ARANE

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of the Ancient Near East

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The International conference
of Near Eastern Archaeomusicology
Volume I - 2009

From the Editor

The Archaeomusicologigal Review of the Ancient Near East was created out of necessity.
For the past decades, archaeomusicology has suffered from academic discrimination and found it very difficult to find its niche in most of the periodicals dedicated to researches in the Ancient Near and Middle East.
The reason given, generally, is that archaeomusicology is perceived as part of philology by musicologists and as musicology by philologists, and is mainly ignored by both organologists and archaeologists.
Only papers written by rare assyriologists, often with limited if not inexistant knowledge of musicology, found their way to the press.
As a result many colossal misconceptions have been published and absorbed as infallible material by readers, because the merit of the musicology was based on the assyriological reputation of the assyriologists and not on their reputation as musicologists.
Today, the launch of ARANE aims at redressing this.
It will give an opportunity for archaeomusicology papers to be published, with all the scientific respect that is due to them, so that their authors may be academically rewarded for their work which otherewise would have remained ignored.

The first conference of ICONEA, International Conference of Near Eastern Archaeomusicology was held on December 4, 5 and 6 2008, at the British Museum.
Leading archaeomusicologists had gathered for this occasion and produced excellent papers in all aspects of the science.
The succes of this first conference has prompted the organisers in having a yearly recurrence of the event.
ICONEA 2009 will take place in the prestigious university of the Sorbonne, in Paris on November 25, 26 and 27.
On that occasion, the event will be split in two parts. Papers will be heard in the morning and round-tables will be held in the afternoon. The theme will be comparative organo-philology.
We hope to see you there.

Richard Dumbrill

ARANE

Archaeomusicological Review of the Ancient Near East

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BM 133010
PRN: WCO47732; Reg. No. 1961,1208.3; Additional ID: ND.11226 ca.900BC
Found at Nimrud, Fort Shalmaneser, by the British School of Aracheology in Iraq who subsequently donated it to the British Museum.

BM 133425
PRN: WCO23245; Reg. No. 1963,1214.11; Additional ID: ND.12519
Neo-Hittite (900BC)

Found at the site of Nimrud, Fort Shalmaneser by the British School or Archaeology in Iraq and donated to the British Museum in 1963.

This object was given to Shalmaneser III, King of Assyria (858-824BC), by Urhilina, King of Hamath, now Hama, in Syria, whoswe name appears in Luwian hieroglyphs on the underside. It appears that 133011, above, was part of the gift.
(Pair with 1962,1208.2 [BM133009])

THE TONAL SYSTEMS OF MESOPOTAMIA AND ANCIENT GREECE : SOME SIMILARITIES AND DIFFERENCES

Leon Crickmore

During the twentieth century musicologists made considerable advances in their understanding of the tonal system of ancient Greece. During the last decade our understanding of the music theory of Mesopotamia has been similarly broadened. This paper highlights the main similarities and differences between the two systems which have emerged from this research.

In the early 1930s, Wilfred Perrett,[1] addressing the Musical Association commented that:

> *'The only professor of Greek I have ever known who was also a musician always refused on principle to give me any help with a stiff passage from a Greek author on music. His reply was always the same: 'Put that stuff away. Nobody has ever made head or tail of Greek Music, and nobody ever will. That way madness lies.'*

In a not unsimilar vein, a few years ago the editor of a distinguished academic journal for Oriental Studies rejected a paper from the present author with the remark: 'we do not publish articles on music or astronomy'. Fortunately, all this has now changed, or, at least, is changing. Despite the limited amount of actual music surviving from ancient Greece and Mesopotamia, musicologists now have a fair grasp of the music theory of both of these civilizations. Perhaps the most succinct and accessible account, both for musicians and for the general reader, of the fruits of recent research into the music of ancient Greece is the article by Thomas J. Mathiesen in the New Grove Dictionary of Music and Musicians[2]. Or there is Mathiesen's book Apollo's Lyre.[3] Whilst from Britain, on the classical side there is Martin West's Ancient Greek Music[4], and the papers of the 1999 colloquium at the University of Warwick, published under the title Music and the Muses; the Culture of '*Mousike*' in the Classical Athenian City[5]. A comparable summary in the New Grove Dictionary of Music and Musicians of the research findings from Mesopotamia is Anne Kilmer's entry 'Mesopotamia'.[6] Or from Britain, there is Richard Dumbrill's book: The Archaeomusicology of the Ancient Near East.[7] Music must have played a much more significant role in these ancient societies than has generally so far been acknowledged. Crickmore[8] has highlighted this by making a re-valuation of what he calls 'the ancient science of harmonics'.

The aim of this article is to explore the main similarities and differences between Mesopotamian and ancient Greek music theory which have emerged from recent research. Much of the evidence upon which this enquiry is based is inevitably circumstantial and dependent on musicological interpretation. But its mathematical consistency and compatibility with what is now known about Mesopotamian and ancient Greek mathematics warrants its serious consideration by scholars of other relevant disciplines.

The Mesopotamian Tonal System

Kilmer's interpretation of the Akkadian tuning system rests mainly on the evidence of CBS 10996.[9] [10] But her pioneering research soon ran into difficulties as a result of the publication and subsequent discussion by both assyriologists and musicologists of the cuneiform tablet UET VII, 74. When Gurney[11] published his first transliteration of this tablet, everyone assumed that the Babylonian heptachords were rising scales. However, it was not long before the musicologist, Vitale[12] made the suggestion that the string descriptions 'thin' and 'small' in UET VII, 126 implied falling scales. Next the assyriologist, Krispijn[13] suggested an improved reading of a damaged line of UET VII, 74, which confirmed Vitale's view that the scales should be descending. In consequence, Gurney[14] issued a revised transliteration. All of this left Kilmer, in her own words, 'on the horns of a dilemma'[15]. For in accordance with her interpretation of the tuning system described in CBS 10996, rising and falling scales would have different names from each other. The present author has recently published a possible resolution of this dilemma[16] [17]. Whereas our modern scales, like those of ancient Greece, are ladders of pitches, which in the opposite direction simply comprise the same pitches in the reverse order, the Babylonian heptachords were fixed modal patterns which remained constant regardless of the direction - rather like, for example, the upper tetrachords of our modern melodic minor scales.

At this point it may prove worthwhile to summarize briefly the musicological significance of each of the main musical cuneiform texts. First, CBS 10996, which is a Neo-Babylonian text published by Kilmer in 1960[18]. She interprets the numbers in the text as representing fourteen pairs of strings (dichords) on a seven-stringed instrument. Seven of these dichords define the 'rough' tuning of the instrument by means of perfect fifths and perfect fourths. The remaining seven indicate the necessary 'fine-tuning' of the thirds and sixths in order to make them sound 'sweeter'[19] - that is, in effect, modifying the original Pythagorean

1		2		3		4		5		6		7	String number
Modal Pattern (string intervals)													Name
	s		t		t		t		s		t		*išartum*
	t		s		t		t		t		s		*embūbum*
	t		t		s		t		t		t		*nīd qablim*
	s		t		t		s		t		t		*qablītum*
	t		s		t		t		s		t		*kitmum*
	t		t		s		t		t		s		*pītum*
	t		t		t		s		t		t		*nīš* GABA.RI

Fig.1. Modal patterns of the heptachords by name

tuning in a manner which would make it approximate more closely to just tuning. The complete process enables a musician to tune his or her instrument to seven heptachords in an upward and downward direction (Appendix I). Second, UET VII, 74, an older, Old Babylonian text. This text describes a cyclic method of tuning and re-tuning a nine-stringed instrument through seven modes in an upward and downward series. The procedure involves the 'tightening' (sharpening) or 'loosening' (flattening) of one of the components of the 'unclear' interval (la zaku) - the tritonic dichord. The series finally leads the player back to the mode initially tuned, now transposed either up or down a semitone. UET VII, 74 was first correctly interpreted musicologically by Dumbrill[20] (Appendix II). The third text, UET VII, 126 is a late Babylonian copy of an item in *Nabnitu*. It contains a palindromic numbering system for the strings of a nine-stringed instrument: 1, 2, 3, 4, 5, 4, 3, 2, 1.

Various interpretations have been suggested: the use of symmetric standing lyres requiring two players[21]; a static fifth string throughout the tuning process[22]; a geometric mean between tone-numbers.[23] While there is a partial truth in each of these explanations, Richard Dumbrill and the present author have now agreed that the numbering simply represents an alternative tuning procedure to the one described in CBS 10996. First, the fifth string is tuned (D4 in my transcription). Second, the pair of strings (1-1) is tuned by reciprocal fifths, upward and downward (5-1), This is followed by the string-pair (4-4), tuned similarly through reciprocal fourths (1-4). Third, the overlapping fifths (4-2) complete the tuning, except for the 'unclear' interval (3-3). The instrument is now tuned to the 'open' string tuning ('*pītum*'). The cyclic procedure of UET VII, 74, involving the correction of the tritones can now be applied to tune the remaining six heptachordal scales (Appendix II and Appendix III). Appendix III also relates the Babylonian string-names to the corresponding terminology used in ancient Greece. However, it is the most recently published musical text (CBS 1766) which has finally brought the Mesopotamian tonal system wholly into musical focus.

CBS 1766 is unusual in that the tablet is headed by a seven-pointed star enclosed in two concentric circles (Appendix IV). It is a badly damaged tablet of uncertain date and provenance. On its own it remains ambiguous. But in the context of the other musical tablets its overall purpose and unifying function seems clear. When Horowitz first published CBS 1766 in 2006[24] he read the figures below the star in pairs horizontally and proposed a mathematical interpretation. But Waerzeggers and Siebes[25] were quick to suggest an alternative musical interpretation. If the pairs of integers between one and seven are read by column, rather than by line, they match the numbers of the paired strings (dichords) in the tuning text CBS 10996. The figures can then be related to the seven-pointed star, which should be interpreted as a visual tuning-chart for seven heptachords on a seven-stringed instrument, supplementing the numerical and verbal instructions in CBS 10996.

A recent research-note by Crickmore[26] provides a detailed musicological and mathematical context for the tablet.

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
2	6	1	7	5	4	3	2
6	3	5	4	2	1	7	6
3	7	2	1	6	5	4	3
7	4	6	5	3	2	1	7
4	1	3	2	7	6	5	4
1	5	7	6	4	3	2	1
5	2	4	3	1	7	6	5

Fig.2a

Key		
A	*išartum*	(6 emended to 5)
B	*kitmum*	
C	*nīš* GABA.RI	
D	*pītum*	(5 emended to 4)
E	*qablītum*	
F	*nīd qablim*	
G	*embūbum*	(7 emended to 3)
H	return to *išartum*	

Fig.2b

Figure 2 indicates how the text (with three emendations) might have originally been intended to be understood. The names of the heptachords produced by the tuning system as interpreted by Kilmer are listed and identified by the capital letters used by Horowitz to mark the columns. In the original the last four columns on the right are empty except for line one. The numbers in columns E,F,G and H are extrapolations from Waerzeggers and Siebes's reading of the first line as 5,4,3,2. However, a team at the British Museum has recently suggested an improved and extended reading: 5,2,5,2,5,2. Since 5-2 is the tritone in the *išartum* scale (column A), its triple use over empty columns may be a kind of musical shorthand to indicate the application of the tritone correction procedure from UET VII, 74 (Appendix II) to the scales defined in detail in columns A-D, with a view to generating heptachords for columns E-H. The application of this procedure would, in effect, produce an identical result to the extrapolation in figure 2. Alternatively, the integers 5 and 2 might refer to the heptachords *qablītum* (initial tuning 5-2) and *išartum* (2-6) as the approriate modes for certain classes of incantation which may be listed in the textual heading to the geometrical figure and relate to certain styles of music as listed, sometimes with their appropriate mode named, in the song-list KAR 158. However, as long as the verbal heading remains almost indecipherable, and the overall context remains musical, it may be taken that Waerzeggers and Siebes's interpretation adequately represents the most likely intention of the author of CBS 1766.

Figure 3 shows the seven-pointed star from CBS 1766 interpreted as a tone-circle. The seven Babylonian heptachords are displayed as falling clockwise and rising anticlockwise. The initial 'rough' Pythagorean tuning by fifths and fourths is indicated by the chords of the star (eg 2-6, 3-7 etc.), while the 'fine-tuning' in the direction of Just tuning is marked by dotted lines (*eg.,* 1-6, 2-7 etc.). Lightly dotted lines are extended from the centre to the outer circle. The numbers and letters along these give the respective tone-numbers from the standard mathematical tables and their hypothetical modern pitches. The Just tuning ratios between the strings are also included. Falling scales are named in lighter and rising in heavier type with underlining. The whole diagram is characterized by

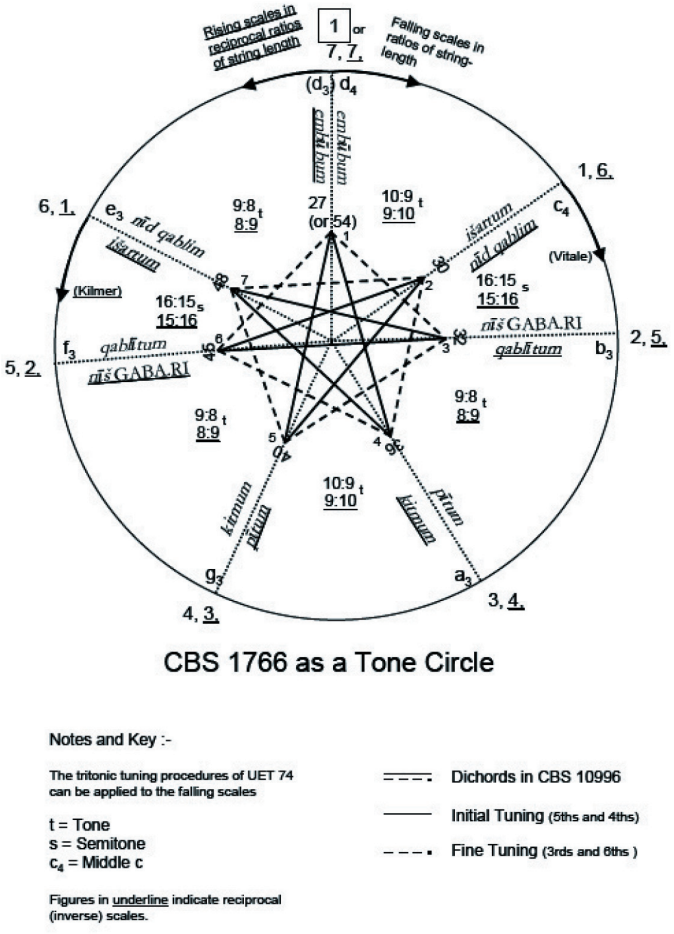


Fig. 3

a symmetry which is likely to have been a central consideration in Babylonian thought, and possibly the basis of various other analogical applications of these relationships in such fields as astronomy and architecture.

Possible Mathematical Origins

Dumbrill[27] hypothesizes that the fretting of lutes may have been the origin of the use of fractions and ratios of string-length and proportional arithmetic by instrument-makers and musicians. Crickmore's hypothesis[28] [29] postulates that the theoretical musicians of ancient Mesopotamia quantified their scales, using sexagesimal arithmetic and tone-numbers taken from their standard tables of reciprocals and divisors, of which there are numerous examples. Additionally, each of the papers cited above makes a separate case - albeit based largely on circumstantial evidence - for the use by Babylonian musicians of just rather than Pythagorean tuning. The musicologist, Crocker[30] suggested that the Babylonians could have quantified their scales, adding 'they certainly had the mathematical capacity - indeed the needed numbers are there in the mathematical texts'. But Gurney and West[31] retorted that 'since there is no evidence that the Babylonians had any notion of this, there is little point in speculating that they might have done, or that such evidence might yet turn up'. Moreover, in the West, the earliest documentation for Just tuning is in

the Harmonics of Ptolemy[32]. However, since the relevant mathematical tables list 'regular' numbers only - that is, numbers in the form ($2^p3^q5^r$) - any tuning system derived from them would be bound to be just. So the remaining question is whether we have any evidence which suggests that these tables had a musical connotation. If interpreted as tone-numbers, each of the regular numbers in the left-hand columns of the relevant tables has a musical equivalent, defining a pitch-class in terms of fractions or ratios of string-length (Appendix V). Appendix V is based on Hilprecht's transliteration of the reverse side of the tablet shown in his Plate 20[33]. Superscript numbers indicate the octave of each pitch on a modern piano[34] (C4 = middle C). Transposition up or down an octave is equivalent to multiplying or dividing a tone-number by two *e.g.*, 2,4,8,16 all generate B (falling) or F (rising). With regard to defining pitch-class, the specific octave is irrelevant. Some American musicologists refer to this phenomenon as 'octave equivalence'. Such tables - like CBS 10996 and CBS 1766 which are restricted to the first seven integers - could have formed another class of tables that served a musical purpose. Hilprecht[35] also draws attention to an anomaly in the standard tables of divisors/reciprocals. They all comprise two columns of figures: divisors (or regular numbers) on the left with their respective quotients (or reciprocals) on the right. However, in the first lines of these tablets, whilst the quotient is always 2/3, the divisor is given as 1 rather than 1½ (3/2). If the cuneiform wedge is read as 60, 2/3 = 40, a number which was associated with the god Ea, patron of music. In the epic Gilgamesh[36] the name of the boatman who sails across the waters of death is Urshanabi (old Babylonian *Sursunabi*) which means 'servant of two-thirds', that is Ea. A fret placed two-thirds of the way along a string of 'sixty fingers' length would sound a perfect fifth (3:2) above the original note. According to Kilmer's interpretation of CBS 10996, an upward perfect fifth is the first interval of the

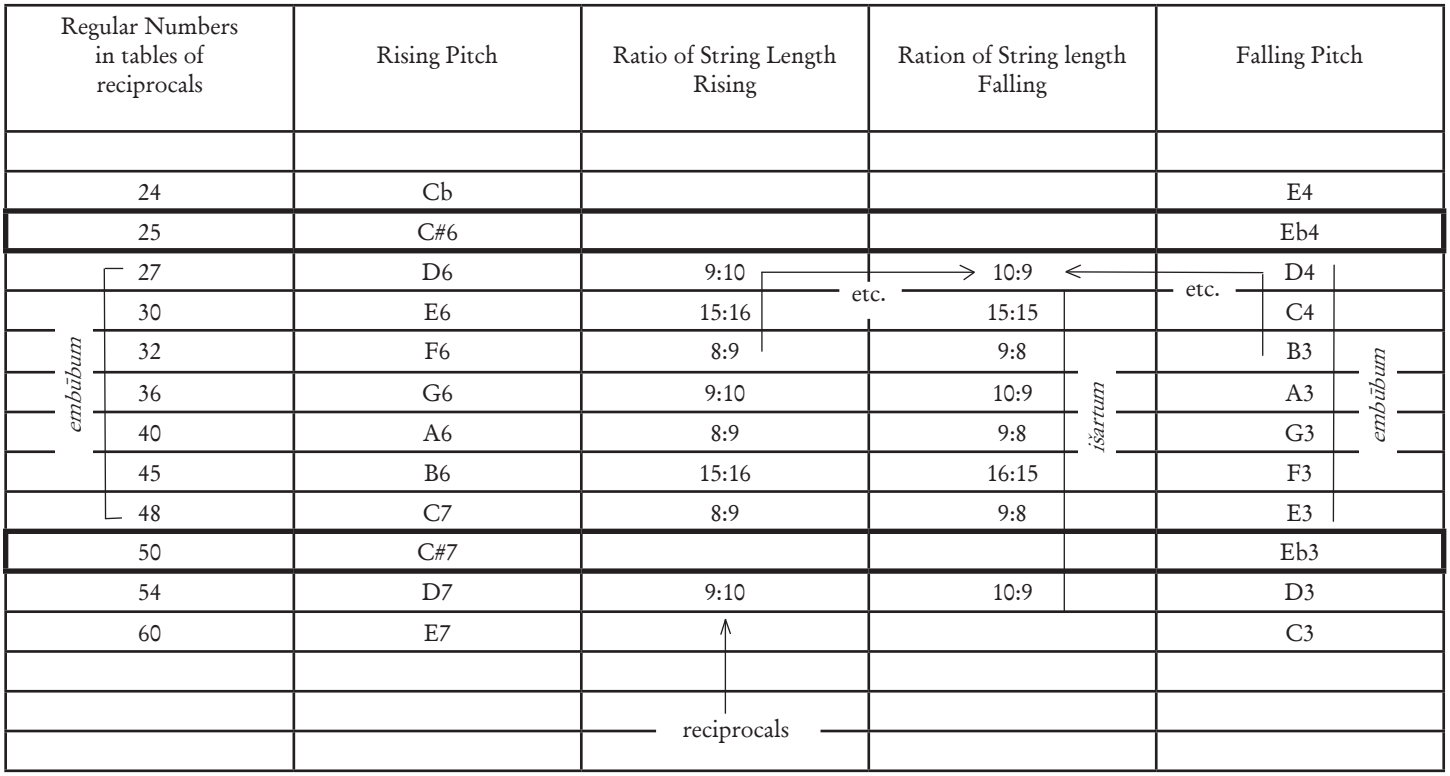


Fig. 4

But it is only from 27 upward that a continuous diatonic scale is generated. The segment 27-48 has already been projected onto the seven-pointed star of CBS 1766 (Figure 3). Figure 4 highlights the musical significance of this range of numbers in the context of just tuning.

An Anomaly in the Mathematical Tables

Most of the mathematical division and multiplication tables list all the numbers from 1-20, and then 30, 40 and 50. But a few tables - usually those on tablets which contain more than one table - consist of regular numbers only ($2^p3^q5^r$). Hilprecht interprets these tables as lists of divisors of 12,960,000 (60^4) so that the whole columns of quotients are integers. Akkadian tuning procedure.

In UET VII, 126 a certain string is listed as 'fourth, small' in Sumerian and 'Ea-created' in Akkadian. Let the number 40 be assigned to the fourth string of a seven-stringed instrument, and all other tone-numbers be taken from the left-hand column of a standard mathematical reciprocal table. The tone-number of the first string would then be 30 - a number associated with the god, Sin and the quotient of the second line of the relevant tables. Continuing until we have a full heptachord (omitting 50 which is chromatic), the result is: 30, 32, 36, 40 48, 54. The ratios between these tone-numbers define a diatonic scale in Just tuning: 16:15, 9:8, 10:9, 9:8, 16:15, 9:8,

or in modern letter-notation: E,F,G,A,B,C,D (rising in ratios of inferred frequency of vibration) and C,B,A,G,F,E,D (falling in ratios of string-length). Such a scale proves to be none other than the heptachord *išartum* ('normal'): stttst.

When describing the tablet which forms the basis of Appendix V, Hilprecht notes[37] that the text is 'written three times alternately with 50 x 1'. In cuneiform notation the wedge can be read as 1 (ges), 60 (goss), 602 (sar), 603 (sargal) and 604 (sargal-su-nutag). Hilprecht shrewdly recognises that the last of these is identical with Plato's 'sovereign geometrical number' (Republic,546c); 12,960,000. Plato's Muses (Republic, 546b) refer to the numbers 60, 602 , 603 , and 604 , as 'four limits' (horoi) and the ranges of integers between them as 'three distances' (apostaseis)[38]. Appendix VI has been constructed on the assumption that the triple repetition of the table in Hilprecht's Plate 20 (reverse) may relate to three different values for the wedge and three different consequential multiplications by fifty. It will be observed that the fractions in column 3 of Appendix VI, as fractions of a string-length 60, in the range 30-54, provide an alternative numerical definition of the heptachord išartum. The octave 144-72 in column 4 highlights the reciprocal octave in integers of 30-60 in the first column[39]. The regular numbers 54, 72 and 96 (the octave-doubles of 27, 36 and 48, which define the same pitch-classes) when multiplied by fifty give 2700, 3600 and 4800, respectively. 2700:3600 and 3600:4800 are the 'two harmonies' referred to by Plato in the passage from the Republic already cited. Furthermore, the product of the outer pair (2700 x 4800) is again Plato's 'sovereign geometrical number' (604), as also is 36002, 3600 being the geometric mean between 2700 and 4800. In his Timaeus (31c) Plato describes the geometric mean as the 'fairest of bonds'. The present author has also illustrated[40] that if used as limiting tone-numbers, the range 2700-4800 can accommodate the seven Babylonian heptachords. These three key numbers occur once more in column 5 of Appendix VI. Hilprecht suggests that we should not regard the anomaly in the mathematical tables as a mathematical error, but rather as an 'abbreviated expression well understood by the Babylonians'. Is it fanciful, therefore, to suggest that this understanding might quite simply have been the recognition that the numbers in these tables have a musical connotation?The Mesopotamian system of Just tuning which in principle has been derived from their standard mathematical tables, like the arithmetical interpretations of the basic wedge sign, is characterized by considerable diversity. To our modern scientific outlook this may seem somewhat unscientific, but within the Babylonian cultural setting it probably offered a beneficial flexibility. There were two forms of tone (10:8 and 9:8), three forms of semitone (16:15, 25:24 and 27:25, all required to specify a chromatic scale in the octave 360-720), and even two forms of the perfect fifth and fourth (normally 3:2 and 4:3) but also with these ratios reduced and increased respectively by a syntonic comma (80:81 and 81:80) to become 40:27 and 27:20 - all numbers in the relevant mathematical tables. Figure 5 provides an arithmetical model in integers for the *embūbum* heptachord and the chromatic scale excluding the tritone, in just tuning.

The Greek Reformation

With their logical outlook on life, it is not surprising that the ancient Greeks felt a need to standardize the Babylonian tonal system and give it a distinctive Greek form. In Pythagorean tuning all the tones are 9:8. A consequence of this is that the semitones are too small: that which is 'left over' (*leimma*) when a diatonic third (9/8)2 is taken from a perfect fourth (4:3), namely, 4/3 divided by 81/64 = 256:243. Documentary evidence for Pythagorean tuning can be found in Plato's Timaeus (34-37), a mythological description of the making of the 'World Soul', defined mathematically in the manner of a musical scale. The first octave of the 'World Soul' scale turns out to be the Dorian octave species expressed through the tone-numbers 384-768. The second to the ninth terms of this series (432-864) defines the Phrygian octave species. The Dorian and Phrygian modes are the only two which Plato is prepared to admit into his ideal city-states The small interval which modern acousticians call the 'syntonic comma' is the ratio between the last two items in Appendix V (80:81). It defines the difference between a ditonic third in Pythagorean tuning (9/8) and a pure third in Just tuning (5:4), thus exhibiting the characteristic difference between the two tunings. In Figure 6 the last two columns on the right show the Pythagorean tuning of the Dorian and Phrygian octave species in accordance with Plato's formula for the construction of the 'World Soul' in his Timaeus. Moving leftwards, the next two columns indicate the first seven tone-numbers in the same arithmetical range that define the corresponding Babylonian heptachords '*nīd qablim*' and '*embūbum*'. In these columns the tuning is just. Pitches which have been reduced by a syntonic comma (x 80/81) are shown in brackets. A hint that the theoretical musicians of Mesopotamia could have been familiar with the arithmetic of the syntonic *comma* is provided by a mathematical problem of a later date discussed by Friberg[41]. Commenting on exercise 7a in the Seleucid text AO 6484, he writes: 'In this exercise, the terms 'igi' and 'igi-bi' denote a 'reciprocal pair' of sexagesimal numbers, by which is meant any pair of (positive) sexagesimal numbers such that their product is equal to '1' (or any power of 60)'. Friberg gives the solution to the problem: igi = 81/80 and igi-bi = 80/81. Finally, on the left of Figure 6 stand the original regular numbers -the arithmetical origin of these scales - as they occur in the standard Mesopotamian tables of reciprocals/divisors. In the subsequent columns the Babylonian tone-numbers have been multiplied by 16 (2^4), which does not alter the pitch-class they signify. It is the belief of the present author that

figure 7 demonstrates a possible evolution of the arithmetic of the ancient Greek Greater Perfect System from the Babylonian tonal system, itself derived from their standard mathematical tables. Returning to Appendix V, on the extreme right the origin of the ancient Greek Greater Perfect System is indicated between the tone-numbers 18 and 72, in its traditional pitch-range: A -A. However, F is missing, since its tone-number (22.5) would have been invalid, since it is not an integer. To overcome this, the whole range has to doubled (ie 36-144). The new tone-numbers are then multiplied by 16 (2^4) to fall within the extended series of the 'World Soul'. The smallest integers capable of defining the ancient Greek Greater Perfect System in Just tuning are 180-720, and in Pythagorean tuning 576-2304. To incorporate the B flat of the Greek Lesser Perfect System the numbers have to be multiplied by two again: B flat is 2187 in the range 1728-4608. Figure 7 lists the ancient Greek Greater Perfect System to base 576, by string-name, hypothetical modern pitch, tone-number (in both Pythagorean and just tuning) and the respective tuning ratios.

Conclusions

In this final section, the main similarities and differences between the Mesopotamian and ancient Greek tonal systems will be summarized.

Similarities

1. Music was central to the cultures of Mesopotamia and ancient Greece. It featured in the rituals of the temples, and on many other civic, social and informal occasions.

2. Music in Mesopotamia and ancient Greece was primarily diatonic[42] and modal - that is, based on conventional patterns of tones and semi-tones. In both Mesopotamia and ancient Greece there were seven such modes.

3. Ancient music was initially notated by means of string-names rather than pitches.

4. Nevertheless, the theoretical musicians of Mesopotamia and Greece quantified the relative pitches of their scales, using proportional arithmetic. The resulting mathematics linked music to their cosmologies.

5. Very little actual music has survived from either culture, but during the last century musicologists have reached a fair understanding of their respective music theories.

Differences

1. The Mesopotamians used Just tuning ($2^p3^q5^r$), originally derived from their standard tables of reciprocals. The ancient Greeks used Pythagorean tuning (2^p3^q), as documented in Plato's Timaeus.

2. The Mesopotamian scales were conjunct heptachords (7-note scales, in which the two tetrachords shared a common central note). The Greek scales were octachords (8-note octave species, with a disjunction).

3. The Mesopotamian tonal system was intrinsically symmetrical. Thus scales in the opposite direction (rising or falling) were the inverse or reciprocal scales of each other - that is, the same modal pattern in the reverse direction.

In ancient Greece, however, as in our modern music, each scale was a ladder of pitches. The Greeks defined their scales in a downward direction. The identical mode, rising, would comprise the same pitches, rather than the same modal intervals, in the reverse direction.

To conclude: the evidence cited from archaeology, musicology and the history of mathematics indicates the likelihood of the existence of a musical and mathematical tradition - possibly partly oral and with other significant extra-musical associations -in the ancient Near East, lasting at least from nineteenth century Mesopotamia until fourth century Greece. A fitting title to describe the serious study of this emerging body of evidence which would distinguish it - as is unfortunately necessary - from other less rigorous speculation, might be 'harmonic mythology[43]'. If such a classification were to prove acceptable to scholars, it would serve as a suitable title for a fresh and fruitful field for continuing interdisciplinary research.

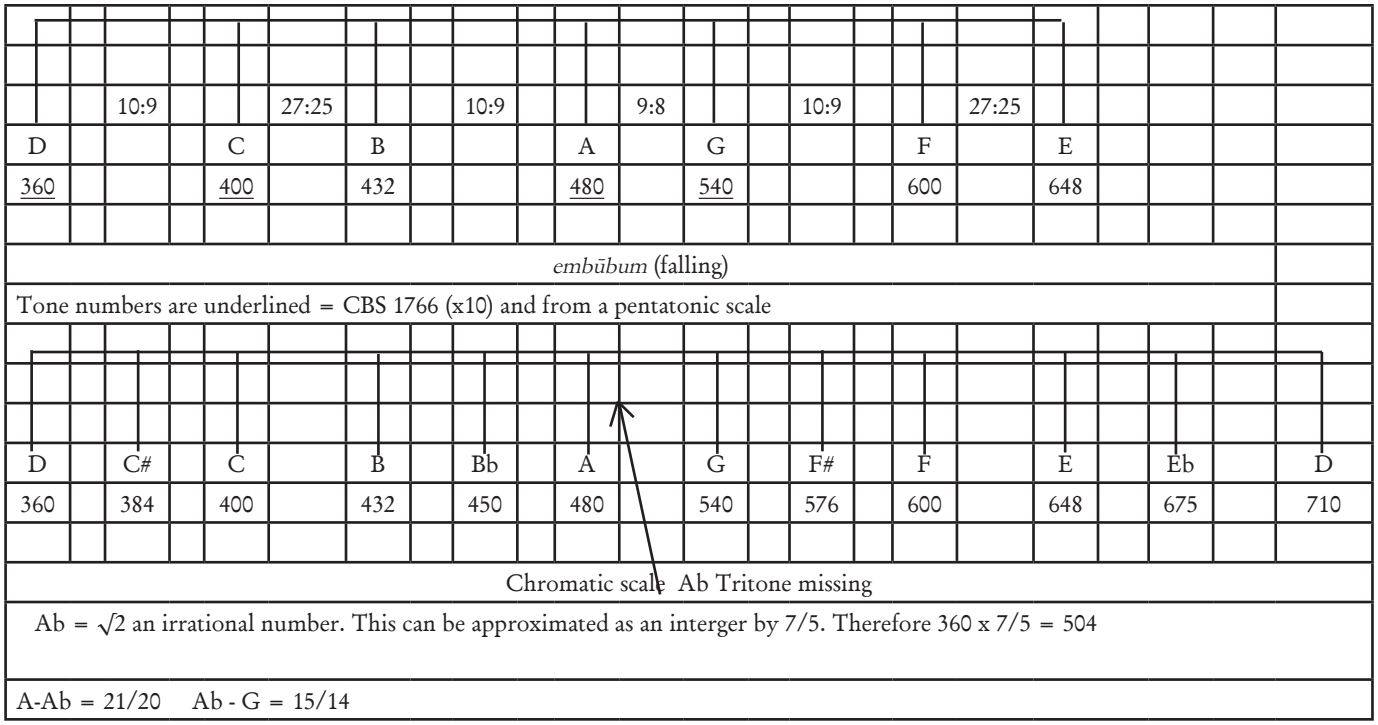

10:9 27:25 10:9 9:8 10:9 27:25
D C B A G F E
360 400 432 480 540 600 648
embūbum (falling)
Tone numbers are underlined = CBS 1766 (x10) and from a pentatonic scale
D C# C B Bb A G F# F E Eb D
360 384 400 432 450 480 540 576 600 648 675 710
Chromatic scale Ab Tritone missing
Ab = √2 an irrational number. This can be approximated as an interger by 7/5. Therefore 360 x 7/5 = 504
A-Ab = 21/20 Ab - G = 15/14

Figure 5

1	2	3	4	5	6	7
		24	e’		384	-
t	9:8			9:8		
		27	d’		432	432
t	10:9			9:8		
		30	c’		486	486
s	16:15			256:243	(480)	(480)
		32	b		512	512
t	9:8			9:8		
		36	a		576	576
t	10:9			9:8		
		40	g		648	648
t	9:8			9:8	(640)	(640)
		45	f		729	729
s	15:16			256:243	(720)	(720)
		48	e		768	768
t	9:8					
		54	d	9:8		884
t	10:9					
		60	c	9:8		

Column 1. Interval

Column 2. Ratio

Column 3. Tone numbers from mathematical tables (just tuning)

Column 4. Hypothetical modern pitches

Column 5. Ancient Greek ratios (Plato: Timaeus 34-37 and Republic 398-399) - Pythagorean tuning

Column 6. Greek Dorian ocyave species (*nīd qablim*)

Column 7. Greek Phrygian octave species (*embūbum*)

Figure 6

String Name	Tetrachord	Pitch	Tone Numbers Pythagorean	Ratio	Tone Numbers Just **	Ratio
Nete	Hb	A^4	576		576	
				9:8		10:9
Paranete	Hb	G^4	648		640	
				9:8		9:8
Trite	Hb	F^4	729		720	
				256:243		16:15
Nete	Hb,D	E^4	768		768	
				9:8		9:8
Paranete	D	D^4	864		864	
				9:8		10:9
Trite	D	C^4	972		960	
				256:243		16:15
Paramese	D	B^4	1024		1024	
				9:8		9:8
Mese	M	A^3	1152		1152	
				9:8		10:9
Lichanos	M	G^3	1296		1280	
				9:8		9:8
Parahypate	M	F^3	1458		1440	
				256:243		16:15
Hypate	M, Ht	E^3	1536		1536	
				9:8		9:8
Lichanos	Ht	D^3	1728		1728	
				9:8		10:9
Parahypate	Ht	C^3	1944		1920	
				256:243		16:15
Hypate	Ht	B^2	2048*		2048	
				9:8		9:8
Proslambanomenos		A^2	2304		2304	

Tetrachords	
Hb	Hyperbolaion
D	Diezeugmenon
M	Meson
Ht	Hypaton

*Fortetrachord synemmenon (Lesser Pefect System) Bb = 2187 in range 1728 - 4608

** Underlined tone numbers are those in column 3 reduced by a syntonic comma (80/81

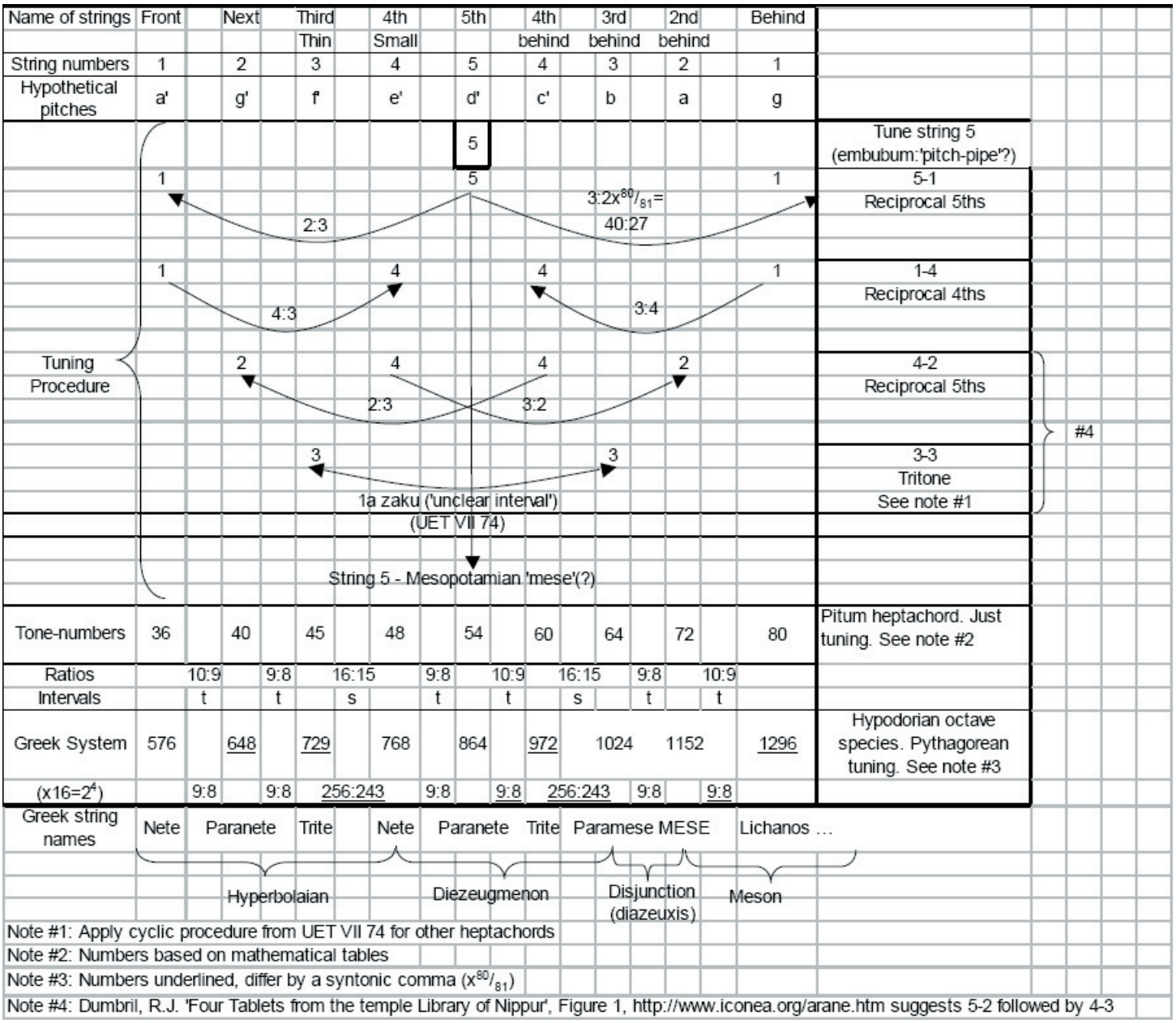
Figure 7

APPENDICES

Appendix I		
Basic tuning	Fine tuning	Heptachoral name
1-5	7--5	(*nīš* GABA.RI)
2-6	1-6	*išartum*
3-7	2-7	*embūbum*
4-1	1-3	*(nīd qablim)*
5-2	2-4	*(qablītum)*
6-3	3-5	*(kitmum)*
7-4	4-6	*(pītum)*

Appendix II - UET VII, 74 tuning procedure. (Text applicable to falling scales only)															
Chapter I (tightening)															
String number	1		2		3		4		5		6		7	Tritone	Re-tuning
Heptachord	*išartum*														
	c''		b'		a'		g'		f'		e'		d'	5-2	#5 for *qablītum*
		s		t		t		t		s		t			
	qablītum														
	c''		b'		a'		g'		f#'		e'		d'	1-5	#1 (and 8) for *nīš* GABA.RI
		s		t		t		s		t		t			
	nīš GABA.RI														
	c#''		b'		a'		g'		f#'		e'		d'	4-1	#4 for *nīd qablītum*
		t		t		t		s		t		t			
	nīd qablīm														
	c#''		b'		a'		g#'		f#'		e'		d'	7-4	#7 for *pitum*
		t		t		s		t		t		t			
	pitum														
	c#''		b'		a'		g#'		f#'		e'		d#'	3-7	#3 for *embūbum*
		t		t		s		t		t		s			
	embūbum														
	c#''		b'		a#'		g#'		f#'		e'		d#'	6-3	#6 for *kitmum*
		t		s		t		t		t		s			
	kitmum														
	c#''		b'		a#'		g#'		f#'		e#'		d#'	2-6	#2 (and 9)for *išartum* (+s)
		t		s		t		t		s		t			
Chapter II (loosening)															
String number	1		2		3		4		5		6		7	Tritone	Re-tuning
Heptachord	*išartum*														
	c''		b'		a'		g'		f'		e'		d'	5-2	^{b} 2 (and 9) for *kitmum*
		s		t		t		t		s		t			
	kitmum														
	c''		b^{b}'		a'		g'		f'		e'		d'	2-6	^{b} 6 for *embūbum*
		t		s		t		t		s		t			
	embūbum														
	c''		b^{b}'		a'		g'		f'		e^{b}'		d'	6-3	^{b} 3 for *pitum*
		t		s		t		t		t		s			
	pitum														
	c''		b^{b}'		a^{b}'		g'		f'		e^{b}'		d'	3-7	^{b} 7 for *nīd qablīm*
		t		t		s		t		t		s			
	nīd qablīm														
	c''		b^{b}'		a^{b}'		g'		f'		e^{b}'		d^{b}'	7-4	^{b} 4 for *nīš* GABA.RI
		t		t		s		t		t		t			
	nīš GABA.RI														
	c''		b^{b}'		a^{b}'		g^{b}'		f'		e^{b}'		d^{b}'	4-1	^{b} 1 (and 8) for *qablītum*
		t		t		t		s		t		t			
	qablītum														
	c^{b}''		b^{b}'		a^{b}'		g^{b}'		f'		e^{b}'		d^{b}'	1-5	^{b} 5 for *išartum* (-s)
		s		t		t		s		t		t			

Appendix III



Appendix IV

Appendix V

Number		Falling pitches (ratios of string length)	Ratios (Just tuning)	Rising Pitches (ratios of frequency)	
2		B^7 etc.	3:2	F^2	
3		E^7	4:3	C^3	
4		B^6	5:4	F^3	
5		G^6	6:5	A^3	
6		E^6	4:3	C^4	
8		B^5	9:8	F^4	
9		A^5	10:9	G^4	
10		G^5	6:5	A^4	
12		E^5	5:4	C^5	
15		C^6	16:15	E^5	
16		B^4	9:8	F^5	
18		A^4	10:9	G^5	
20		G^4	6:5	A^5	
24		E^4	25:24	C^6	
25		Eb^4	27:25	$C\#^6$	
27		D^4	10:9	D^6	
30		C^4	16:15	E^6	
32		B^3	9:8	F^6	
36	See note #1	A^3	10:9	G^6	See note #2
40		G^3	9:8	A^6	
45		F^3	16:15	B^6	
48		E^3	25:27	C^7	
50		Eb^3	27:25	$C\#^7$	
54		D^3	10:9	D^7	
60		C^3	16:15	E^7	
64		B^2	9:8	F^7	
72		A^2	25:24	G^7	
75		Ab^2	16:15	$G\#^7$	
80		G^2	81:80	A^7	
81		g^2		a^7	
		C^4 = middle C	$^{81}/_{80}$ = syntonic comma		

note #1: CBS 1766 (Crickmore,2008b)

note #2: Ancient Greek Greater Perfect System

Appendix VI

Column									
1	2	3	4	5	6	7	8	9	10
Notional Modern Pitches CBS 1766				Divisor	Quotient				
Falling	Ratio	Rising	Ratio	**(Hilprecht P.21)**	$\blacktriangledown = 1$	$\blacktriangledown = 60$	$\blacktriangledown = 60^2$	$\blacktriangledown = 60^3$	$\blacktriangledown = 60^4$
E		C		**24**	1/24	5/2	150	9000	**540,000**
(Eb)		(C#)		**25**	1/25	12/5	144	8640	**518,000**
D	10:9	D	9:10	**27**	1/27	20/9	400/3	8000	**480,000**
C	16:15	E	15:16	**30**	1/30	2	120	7200	**432,000**
B	9:8	F	8:9	**32**	1/32	15/8	225/2	6750	**405,000**
A	10:9	G	9:10	**36**	1/36	5/3	100	6000	**360,000**
G	9:8	A	8:9	**40**	1/40	3/2	90	5400	**324,000**
F	16:15	B	15:16	**45**	1/45	4/3	80	4800	**288,000**
E		C		**48**	1/48	5/4	75	4500	**270,000**
(Eb)		(C#)		**50**	1/50	6/5	72	4320	**259,200**
D		D		**54**	1/54	10/9	200/3	4000	**240,000**
C		E		**60**	1/60	1	60	3600	**216,000**
B		F		**64**	1/64	15/16	450/8	3375	**202,500**
A		G		**72**	1/72	5/6	50	3000	**180,000**
(G)		(A)	Syntonic Comma	**(80)**	1/80	3/4	45	2700	**(162,000)**
g		a		**(81)**	1/81	20/27	400/9	8000/3	**(160,000)**

Column 1	Modern Pitch Falling
Column 2	Tone Ratio
Column 3	Modern Pitch Rising
Column 4	Tone Ratio
Column 5	Tone Numbers for heptachords in smallest integers (27-48)
Column 6	Reciprocals
Column 7	Reciprocals of fractions of string of 60 units length
Column 8	Contains 144-72 ; reciprocal octave in integers of 30-60
Column 9	Contains Plato's 'two harmonies' (Republic 546c)
Column 10	The limiting number (60^4) is Plato's 'soverign geometrcal number'
	Republic 546c

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39

30		32		36		40		45		48		54		60
	18:15		9:8		10:9		9:8		16:15		9:8		10:9	
	15:16		8:9		9:10		8:9		15:16		8:9		9:10	
144		135		120		108		96		90		80		72

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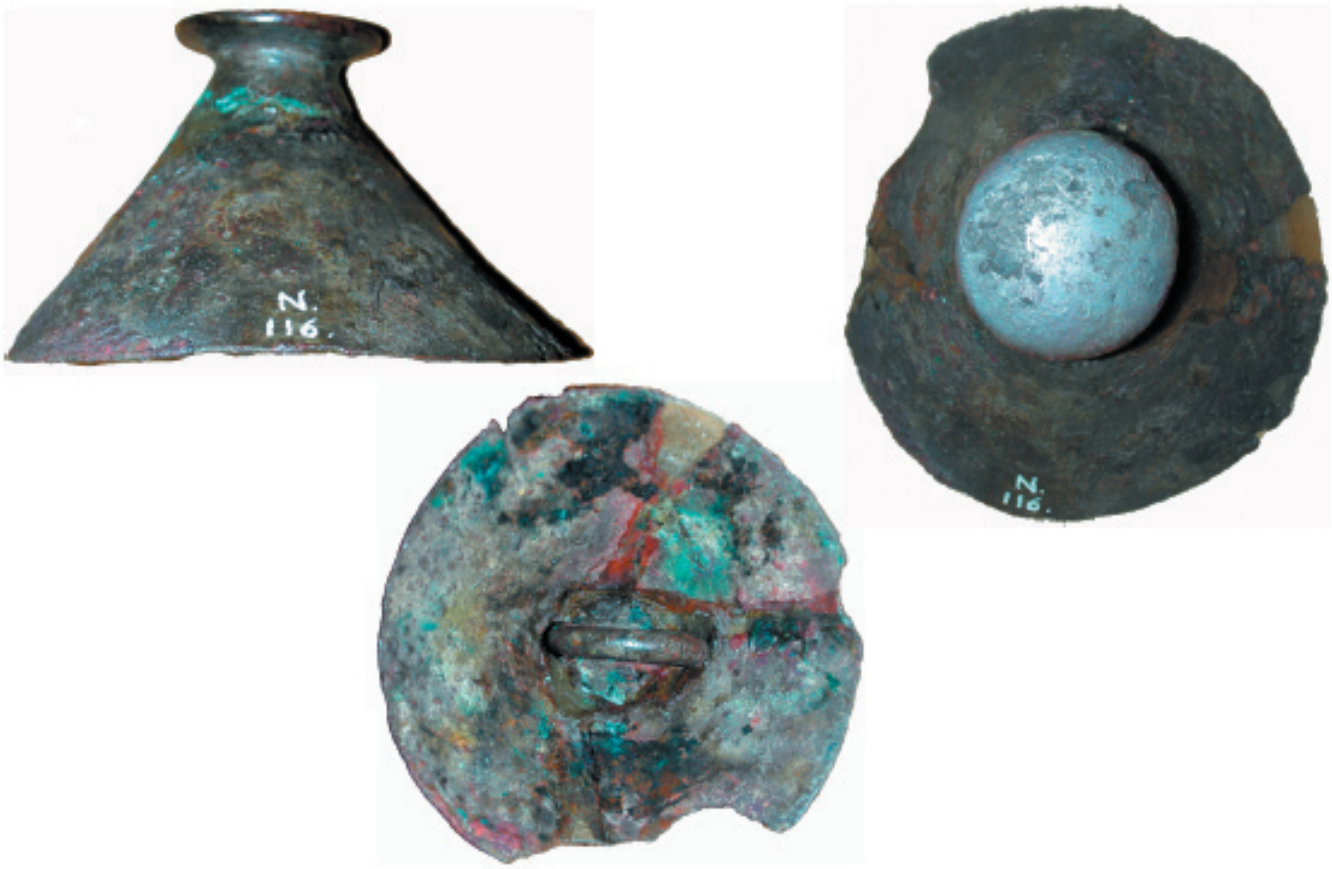

N.116 - Clapper PRN:WCO27196
Excavated by Sir Austen Henry Layard at the site of Nimrud and brought back to the British Museum in 1848 and 1851. 8-9th century BC

BM 91388 - Cymbal
PRN: unknown; Registration Number:1895,1205.301.
Probably from Nimrud, 8-9th century BC.

N.512 - Cymbals
PRN:WCO27810 Excavated at Nimrud

ANCIENT ISRAEL/PALESTINE AND THE NEW HISTORIOGRAPHY OF MUSIC: SOME UNANSWERED QUESTIONS*

Joachim Braun

Of all pre-Christian cultures, none has a music history burdened by preconceived ideas as that of ancient Israel/Palestine. Until the middle of the twentieth century, the entire assessment of the music of ancient Israel/Palestine was based on a single source - the Bible. Regardless of its mythological nature, the theological significance of this source elevated it to the status of an historical document. This one-sided focus prompted an attitude of fetishism with regard to what the Bible actually recounts about musical instruments, musical events, and the local musical culture.

A decade or so ago it became quite clear that we should apply to music the general dictum expressed by Othmar Keel on the study of history of religion: *'Eine Rekonstruktion der Religionsgeschichte Palästinas/Israels... braucht Primärquellen. Solche aber sind nicht in den biblishcnen Schriften zu finden, sondern nur von der Archäologie zu erwarten.'*[1] The genuinely new character of the history of music in this region emerged only at the end of the twentieth century and led to the birth of what I would call 'The New Historiography of Music of Ancient Israel/Palestine'.[2] This discipline, primarily based on archaeological sources, makes use of an interdisciplinary approach which embodies a number of secondary disciplines and sources, such as iconographic, written and comparative geographical, chronological and ethnic sources. It is only natural that in the case of AIP the written biblical sources, and the latest developments in biblical exegesis, are decisive for the study of musical culture.

The conflict between biblical texts and factual archaeological data have recently reached unique pungency as result of abundant archaeological information in recent decades, on one hand, and new developments in biblical studies, on the other. This has given rise to mutual verification, and to the examination of each and every mosaic-stone, which may or may not fit into the overall picture of the musical past or of certain aspects of it. Let me present some examples of this problem.

Fig.1

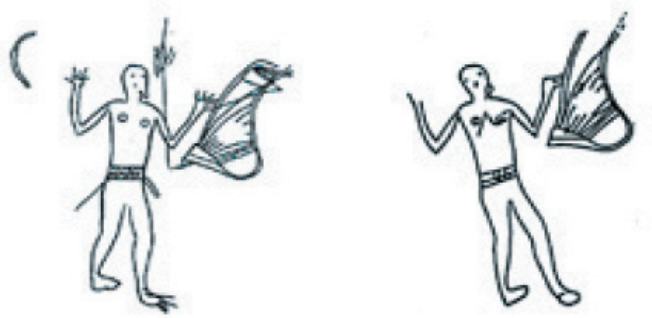

Fig.1a

The disappearance of the Harp in Ancient Israel Palestine

The appearance and questionable disappearance of the harp in AIP can perhaps be illustrated best by retracing the history of the triangular frame harp. We can view an early, if not the earliest depiction of the triangular harp on a floor stone etching from Megiddo (see Fig. 1), dated into the years 3,300-3,000 BC (XX-XIX strata)3. The discovered floor-stones with carved human figures belong to an interior courtyard surrounded by several rooms, one of which contained an altar as part of a shrine or sanctuary. The nine figures include warriors or hunters, dancers, a female harpist and

* This publication, partly based on earlier research, is a revised and expanded version of papers read for the first time at the ICTM Study Group (Paris 1990) and recently at the international conference 'Sounds of Ancient Music' at the Biblical Land Museum, Jerusalem, January 2008.

possibly a drummer. Several features of these figures also suggest that they were part of the magical environment of a cult, perhaps even part of a sacrificial rite.

The so called 'harpist' is a female figure with accentuated breasts, and possibly represents a dancer or a praying woman rather than a musician - her hands are raised and she is not really holding the instrument. There is hardly a single bibliographical source which does not include a reproduction of this stringed instrument and yet, it has frequently been inaccurately reproduced (Fig. 1a and 1b)[4]. The drawing has proven to be difficult to interpret, which probably gave rise to the legend that it actually represents an early version of the lyre. Sybil Marcuse was the first to describe the instrument as 'harplike' or 'possibly a very large lyre.'[5] As a result this instrument appears in the Reallexikon der Assyrologie und Vorderasiatischen Archäologie both in two different articles – one on the harp, the other on the lyre. This confusion went on up to the latest publications, such as Dumbrill's The Archaemusicolgy of the Ancient Near East.[6]

But the drawing from Megiddo unmistakably depicts a triangular frame harp.[7] Its clearly discernible resonator forms the instrument's horizontal basis. Two side arms, one fairly straight and the other elegantly curved in toward the first, are attached to this base and together delineate a three-corner frame. The shorter strings are on the side furthest from the player, a feature incompatible with the bowed harp or angular harp, but certainly typical of the triangular frame harp (reconstruction of Prof. John Kenny, Edinburgh University see Fig. 2). The drawing does not bear a single feature associated with the lyre (for example, the most notable part of the lyre - the yoke - is absent).

A direct continuation of this chordophone type appears at the end of the third millennium within the Cycladic cultural sphere as the triangular classic threecornered harp in the hands of a seated performer. It is rendered here with a characteristic swan's head (Fig.3).[8] A similar harp player, dated into the late third millennium, was recently discovered in Anatolia.[9] During the following millennium we have no indication of the triangular frame harp, until the 8th century CE, when in Christian iconography we find evidence of the so called European frame harp with front pillar. While this type of harp became the main form of the harp in Europe, the ancient triangular frame harp of the Megiddo type can not be substantiated before the late second millennium. In fact, only in the 19th century in the Caucasus in northeastern Siberia we find evidence of instruments shaped and constructed identically to the ancient triangular frame harp (with the shorter strings on the far side of the musician).

These, however, are ethnic folk-instruments, such as the ayum'a of Abchasia, northwestern Caucasus (Fig.4a),[10] or the similar Georgian changi, an instrument that still has features of an animal's head at the upper end,

Fig.2

analogous to the swan's beak on the Cycladic harp.[11] This particular type includes the top-sapl-yukh (literally, 'wooden crane-neck') from Yakutia in northeastern Siberia, an instrument usually constructed with a bird's head (here with a slight indication of the birds beak, Fig.4b) and played as the instrument of the Cycladic marble players more then three thousand years ago.[12]

While harp instruments in general continued to be in use in the neighboring Near Eastern countries, it was only on the Ancient Israel/Palestine territory that there was a total disappearance of any evidence of harps, including the triangular frame harp.[13]

How are we to explain this phenomenon? During the millennia of absence in AIP the triangular frame harp underwent a transformation in the neighboring countries and changed from the ancient professional elite musical instrument, to an ethnic folk instrument.

This instrument may well have originated locally, but did not naturalize in AIP.

The Megiddo harp, one of the earliest depictions of a harp instrument, seems to be another example of the developed artistic tradition indigenous to AIP that evolved from the urbanization processes in the Early Bronze Age.

It appears that during the Canaanite urbanization an enormous variety of culture influences converged to produce, among others, an impressive acoustic revolution.[14] At the same time in the environment of the AIP Dumuzi cult currently with the harp appeared the darabukka-type drum, and somewhat later several idiophones (in particular the clayrattle). Indeed, the Megiddo harp may be understood as a sign - one among others - not only of the appearance of a new autochthonous music instrumentary, but also of an emerging new audio culture.[15]

Very soon, however, the Near East changed. The local Bronze Age grandeur passed, the Canaanite city states were clearly in demise, and the resulting vacuum was filled, at least in part, by an influx of sea-peoples and other groups. In the neighboring countries, especially Mesopotamia and Egypt, a new musically 'eloquent' instrument began to dominate – the lyre, which in the second half of the third millennium BC with its mobile portative form reached high popularity.[16] Moreover, on the borders of Canaan itself this new instrument seamed to be at home. In thirteen known drawings of lyres from the late 3rd-2nd millennia BC, seven stem from AIP[17]. Moreover, the chronologically earliest of this type on a fresco in the Beni-Hassan grotto is depicted in the hands of a Semitic musician (1900 BC), a member of a nomadic tribe on his way from AIP to Egypt (Fig.5).[18]

The Absence of Cymbals between the 12th/11th and 4th Centuries BC

Bronze cymbals, along with clay rattles, were the most common musical instruments found in archaeological excavations of Ancient Israel/Palestine. The unearthed cymbals are of two different sizes (Ø7-12 and 3-6cm, Fig.6) and they belong to two distant chronological periods (the larger size belong to the 14th-12th century BC and the small ones to the Hellenistic-Roman time). Like the clay rattle, the bronze cymbals bridged the transition between the Canaanite and Israelite cultures.

Most scholars have thought cymbals to be the primary instrument used in worship during the time of the First and Second Temple.[19] However, archaeological evidence confronts us with a puzzling chronological situation insofar as not a single example has been found that dates reliably to the Iron Age and Babylonian/Persian period.

Even the five pairs usually associated with the Iron Age actually date to the earliest stage of this period or more correct to the Late Bronze Age, around the twelfth-eleventh century BC.[20] How is this evidence, or lack thereof, to be explained?

Fig.3

The Hebrew term for cymbals, *mtsiltayim*, mentioned in Ugaritic sources as early as the 14th century BC, does not appear in the Old Testament until the post-exilic period. In three passages (Ezra 3:10, Nehemiah and the Chronicles) the instrument is associated with the loftiest cultic events, and as such it is considered as one of the most important ceremonial cultic instruments, the instruments of the Levites, of the Davidic musicians and especially the Asaphites. In the pre-exile texts of the Old Testament another term appears with the same root, tseltselim (probably, a metal plate-rattle). Mentioned in the chronologically disputable reference in 2Sam 6:5, it probably belongs to a very early stage of Judean monotheism. In1Chr.13:8 the parallel passage describes the events of 2 Sam. 6:5, but we now read *mtsiltayim* instead of *tseltselim* – a clearly editorial alternation.

In the first text four percussion instruments and two chordophones are mentioned: in addition to kinnor and nebel, the text mentions atcey broshim (cypress wood clappers),

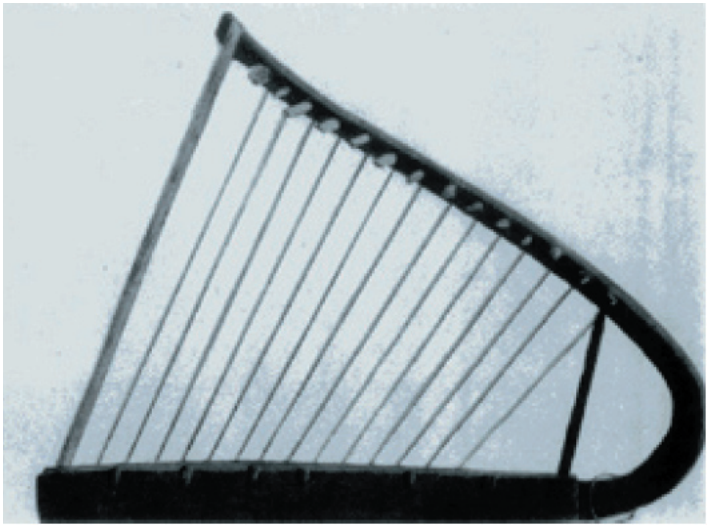

Fig.4a

tupim (drums), *mena'an'im* (clay rattles), and *tseltselim* (type of metal-clappers). In the parallel text 1Chr 13:8, where the same scene is described, the text is altered: two idiophones are eliminated, the primitive rattles (*tseltselim*) are replaced by cymbals (*mtsiltayim*) and singers and trumpeters are added to the ensemble. If in the Samuel context an orgiastic folk band is presented, the second version describes a proper liturgical ceremony at a cult procession. Probably at some point the early text was revised or censored to destroy the image of the pagan sound tools, erase them from folk-memory and create a music accompaniment appropriate for the imaginative reality of the Bible.

The current view about cymbals as a central music instrument of the First Temple is based on the Biblical descriptions only. However, the total absence of archeological evidence for this particular period now casts doubt on this assumption. It was not until the Roman period, when the legend of the First Temple was canonized, that the cymbals underwent a certain process of mythologization and were incorporated into the text to reflect an idealized golden age of the First Temple.

The Discrepancy between Archaeological and Written Sources Regarding The Babylonian-Persian Period

There seems to be a flagrant discrepancy between the biblical descriptions and archaeological finds with respect to the musical culture of the Babylonian/Persian and early Hellenistic Periods, (late 6th-3rd century BC), the time of the Second Temple.[21] According to biblical sources after the collapse of the Babylonian Empire (539 BC) many Judeans returned to their homeland and received permission to rebuild the Temple.

During the following decades the province of Jehuda continued to develop economically and culturally. From historians we know that for this period general sources can be viewed as *'ausgesprochen gut*,'[22] and that with the rebuilding of the Temple, the historical circumstances for cultural and economical developments of the Jewish culture was especially favorable.[23] Historians of music gladly accepted this general view. Indeed, a picture of musical splendor emerges from Biblical sources - the Books of Ezra and Nehemiah (4th-3rd centiry BC). We are told about a surprisingly high number of cult-musicians among those who returned from the exile: over 4000 *kohanim* - priests who blew the trumpets, 74 levites -musicians who played the cymbals, lyres and other instruments, over 100 *mešorerim* - Temple singers and poets, and some 200 to 250 choir singers. The biblical text describes huge processions of singers and musicians marching through the city to celebrate such events as putting the cornerstone of the Temple or building the city-walls of Jerusalem.[24] Josephus Flavius, more or less, confirms the descriptions of the Bible.[25] The later canonical sources – the Mishnah and the Talmud (2nd-6th century) – even go into details: the Temple orchestra allegedly included from two to six *nevalim* (tenor or bass lyres), from two to twelve *halilim* (aulos type instruments), at least nine *kinnorot* (discant lyres) and an infinite number of *hatcotcserot* (trumpets).[26] It is not surprising, that many studies rely on these descriptions and claim that 'we are remarkably well informed'[27] about the music of the Second Temple or that 'the information is often very precise.'[28] Furthermore the legend was enriched and gained musicological reliability: according to well-known ancient music experts, at this time chordophones dominated the temple, the ten-string harp was newly introduced and cymbals were beaten in great numbers outside and inside the Temple.[29]

Reality, however, looks quite different. Archaeology has confronted us here with a surprising gap in archaeological evidence of nearly 400 years with respect to the musical culture of the entire country.

In contrast to the rich amount of finds related to music from the Iron Age (some 170) and the Hellenistic-Roman period (more than 230) we may hardly consider a small handful of musical finds (most of them of uncertain origin), to be decisive regarding the Babylonian/Persian and early Hellenistic periods.[30]

Even if we take into consideration the comparatively short time of this period and the possibly increasing iconoclastic tendencies at that time - it is difficult to explain the striking contradiction between the Biblical descriptions of the musical splendor of the Temple and the total lack of archaeological evidence. Is this an *argumentum ex silentio*? Or is it the case, were absence of evidence does not mean evidence of absence?

So long as we lack a clear explanation for this contradiction, we can hardly rely on the descriptions of musical activity in the Books of *Ezra*, *Nehemiah* and Chronicles or the descriptions in the *Mishnah* and *Talmud* and consider them as historical reality.

Presently, there is probably only one conclusion to be drawn: we have here a case of glorification of the his

Fig.4b

tory of the Second Temple and the invention of a fictitious musical culture necessary for the theocracy's rise to power. To us this period emerges as the time of an unprecedented musical catastrophe which swept the entire country. The archaeological void may have coincided with the pressure of religious and national cultural unification tendencies; the comparatively rich musical culture of the Iron Age collapsed while new incipient musical cultures began emerging, leading to the musical cultures of the Jewish Diaspora Synagogue and Early Christian Church.

Fig.5

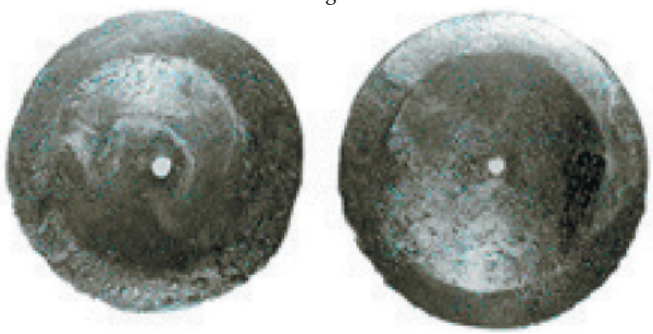

Fig.6

I intended to conclude this paper with a short discussion on another problem, which results not from ignoring the absence of archeological finds, but on the contrary, from neglecting a rich corpus of musical archeology:

The Musical Instrument of the Samaritans

The problem of Samaritan music instruments of pre-Islamic times was for both the Samaritan community and scholarship easily solved: the Samaritans have no music instruments today and never had them in the past due to the indirect Biblical prohibition of musical instruments[31].

Although it is true that the contemporary Samaritan liturgical music does not have any instrumental component and even the shofar is not used, we still do not know when exactly the prohibition against playing music instruments actually took effect.

Apart from the uniqueness of such strange phenomenon in general, the a priori acceptance of an ancient music tradition, such as the Samaritan, void of musical instruments seems to be an unlikely assumption, especially, if we consider the overall cultural environment of AIP. Indeed, archaeology tells us, that the people who accepted the religion now called Samaritanism, populated the geographical area of Samaria at least from the 7th century BC and Samaritan culture blossomed between the 4th-2nd centuries BC, when the Jewish-Samaritan shism and Samaritan self-identification reached its classic form. It was probably at this time that the Samaritan people absorbed a rich instrumental music.[32]

The archaeological evidence on Samaritan music instruments includes three groups of artifacts:

1. Terra-cotta oil lamps, which all have no parallel among Israeli/Palestine or Hellenistic/Roman artifacts, with depictions of different musical instruments, (the shofar, trumpet, double aulos and lyre, Fig.7a). Of special interest are the six oil-lamps from the third fourth century, depicting a portative organ with two pairs of fork cymbals - crotala (Fig.7b). These lamps, which actually may be the earliest substantiation of the organ in the Near East, and appear to be the first known on the territory of Israel/Palestine, are identified by archaeologists as clearly Samaritan.[33]

2. The second is a group of aulos fragments of highly professional workmanship from the 3rd -1st century BC, by some features designated as local production. It seems that it is not by accident that in a list of farmers from a settlement called Samareia in North Egypt (2nd century CE), we find the first written evidence of a Jewish/Samaritan Hellenistic '*klezmer*,' the 'auletis Jacobus ben Jacobus.'[34]

3. Identified as possibly Samaritan are several terracotta figurines with musical instruments. The most interesting among them is one of a bearded man in a tunica and priest's had-cover (which may indicate a Temple musician), carrying a small (25-30 cm) symmetrical lyre on his shoulder (see Fig.8).

It is not without significance that most of the here discussed Samaritan music instruments, are depicted in corpora on a mosaic from early Roman times discovered in 1960 in Hama-Mariamin (South Syria,).[35] This archaeological document shows a female ensemble with pneumatic

organ, cymbals, double aulos, lyre, small bells and a table with water bowls.

The similarity of these instruments with the Samaritan musical finds seems to indicate Seleucid influence in Samaria.

We cannot go here into the complex *pro et contra* arguments regarding the presence of Samaritan instrumental music. The corpus of archaeological finds safely identified as belonging to Samaritan culture, probably, does not allow an unequivocal statement. However, in the context of all that has been said above, we cannot deny the possibility that Samaritans of this time did use musical instruments both in secular and cultic activities. The musical artifacts mentioned here, have autochthon features, musical meaning and artistic style differing from other local musical finds. It is of special significance that we find most of the Samaritan artifacts in a liturgical context. All this may considerably change our assessment of the ancient Samaritan musical culture on the territory of Ancient Israel/Palestine.

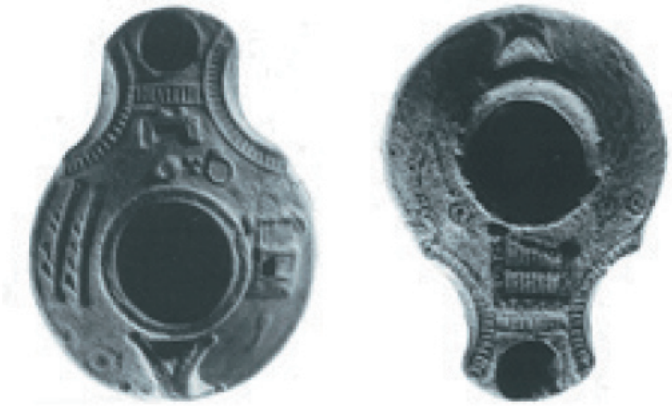

Fig.7 a and b

Fig.8

Fig.9

Notes

1 Keel, O., and Uehlinger, Ch., Göttinen, *Götter und Gottessymbole*, 4th edition , (Freiburg-Vienna, 1998), p.4.

2 See '*Biblische Musikinstrumente*', in: 2MGG, *Sachteil*, (1994), vol.1, pp.1503-1524.

3 Loud, G., *Megiddo II: Seasons of 1935-39*, Chicago, 1948; Lamon, R. S./Shipton, G. M., *Megiddo I: Seasons of 1925, Strata 1-V*, Chicago, 1939.

4 Correct drawing, see footnote 3, Loud 1948, fig.143; incorrect drawing, Stauder, W., *Die Harfen und Leiern Vorderasiens in babylonischer und assyrischer Zei*, (Frankfurt/Main, 1961, fig.11).

5 Marcuse, S., *A Survey of Musical Instruments*, p.381 (New York-London, 1975). Aign, B., *Die Geschichte der Musikinstrumente des Aegäischen Raums*, pp.118-212 (Frankfurt/Main, 1963). A special study on ancient lyres Ancient Middle Eastern Lyres by Åke Norborg (Stockholm, 1995) circumscribes the instrument as 'asymmetrical box lyre... or harp with a forepillar' (p.30), and Bathya Bayer argues that 'it demonstrates the birth of the lyre out of the idea of the harp' (BAR 8/1:19).

6 Dumbrill, R. J., *The Archaeomusicology of the Ancient Near East* (London 2005), p.233.

7 Aign, B., *Die Geschichte der Musikinstrumente des Aegäischen Raums*, pp.118-212 (Frankfurt/Main, 1963). The division of harps in arched and angular harps only (as *e.g.,* by Marcuse 1975, p.381) is not complete; a third group, triangular frame harps divided in two sub-groups should be considered: (a) the triangular frame harps of antiquity, and (b) the later European triangular harps (from the 8th-5th century BC), which developed into the modern harps with front-pillars, as well as ethnic, mostly Asian triangular frame harps.

8 Crane, Fr., 'The Marble Musicians...', paper at 8th International Conference for Arehaeology of Music (Limasol, 1996); Van Schaik, M., *The Marble Harp Players from the Cyclades* (Utrecht, 1998), with depictionsof three genuine Cycladic harpist figurines (pl.1, 10 and 16, see fig.3). The authenticity is confirmed by latest research (see Van Schaik, '*The Presumed Harp-Lyre Transformation in Minoan Crete.*, ms., to be published in 2008/09. I thank Dr. Van Schaik for his kind permission to quote from his unpublished article).

9 Bachmann, W. 'Früzeitliche Musikinstrumente Anatoliens': in: *Orient-Archhäologie vol. 7:Studien zur Musikarchäologie II*, ed. by Hickmann, E., Laufs, I., and Eichmann, R. (Rahden/Wesrf., 2000), pp.148-149, fig.5. This relief engraving on a vessel fragment (10, 5cm.) from Arslantepe (Turkey), highly stylised, nevertheless, allow Dr. Bachmann to claim that the only possible typological parallels for this instrument are the Cycladic marble figurines. The Cycladic harp expert Martin van Schaik suggests that the Arslantepe engraving and the Cycldic harps may have had a similar prototype (see 'The Presumed...' p.5). We certainly may add here that the discussed above Megiddo instrument was one of these prototypes.

10 *Atlas of...*, fig.504.

11 *Atlas of...*, fig.479.

12 *Atlas of...*, fig.733; R. Sadokov, *Muzikal'naya kul'tura drevnego Horezma* [The Music Culture of the Ancient Horezm], (Moscow, 1970), ill.6.

13 Braun, J., *Die Musikkultur Altisraels/Palästinas* (Freiburg Schweiz/Göttingen, 1992 = OBO 164, Table 1 - 2). B. Lawergren (among others see footnote 16) denied in several publications the existence of triangular frame harps in antiquity and rejected as frame harp the Megiddo instrument as well.

14 See J. Braun, 'Music Instruments', in: *The New Interprators Dictionary of the Bible, vol.4* (in Preparation, Abingdon Press, 2009); Braun, J., *Music in Ancient Israel/Palestine* (Grand Rapids/Cambridge, 2002), pp.63-65.

15 Caubet, A., 'La musique du Levant au bronze recent', in: C. Homo-Lechner, ed. *La pluridisciplinarité en archéologie musicale*, (Paris, 1992), pp.129-35.

16 Lawergren, B., 'Lyre', *2MGG*, vol. 4: 1014-1016.

17 Braun, *Music in Ancient...*, tab.2.

18 Braun, *Music in Ancient...*, pp.77-79, fig.III.3; see the thorough analysis of this fresco of Th. Staubli, *Das Image der Nomaden im alten Israe*l (=OBO 107, 1991), pp.30-41.

19 See Sachs, C., *The Histoy of the Musical Instruments* (New York, 1940), p.122-3; Kolari, E., *Musikinstrumente und ihre Verwendung im Alten Testament* (Helsinki, 1947), pp.21-23; Sendrey, A., *Music in Ancient Israel* (London, 1969), pp.376-77; Marcuse, *A Survey...*, p.10; *Encyclopedia Judaica*, vol.12:559 and 566; 1NGD (1980), vol.9:617-618; *Enzyklopedia Mikrait*, vol. 5:767; Keel, O., *Die Welt der altorientalischen Bildsymbolik und das Alte Testament* (Zürich, 1972), p.318.

20 The complicated production requirements and expensive material out of which the cymbals were made preclude any possibility that they were simple mass instruments of the people – 'Volkinstrumente', as is claimed. Also unlikely is the 'nichtkultische Verwendung der Zimbeln,' which allegedly follows from 'archäologischen Belegen der Eisenzeit II', simply because this archeological evidence does not exists, as claimed by H. Seidel, (*Musik in Altisrael*). (Frankfurt-Mainz-Paris, 1989), p.78).

21 On the general Biblical description of this period see Finkelstein I./Silberman, N. A., *The Bible Unearthed*. (Free Press:2001), ch.12. Crucial for the understanding of the Books of Ezra and Nehemiah are the yet unpublished papers of Prof. Israel Finkelstein '*The Wall of Nehemiah*' and '*List of Returnees*'. I am obliged to Prof. Finkelstein for the introduction to the two mentioned papers.

22 Weippert, H., *Palästina in Vorhellenistischer Zeit* (München, 1988), p.693.

23 Davies, W. D./ Finkelstein, L., *The Cambridge History of Judaism: the Persian Period* (Cambridge, 1984), vol. 1:70; Stern, M., *Archaeology of the Land of the Bible, vol. II* (New York, 2001), p.353; Hermann, S., *Die Geschihte Israels in alttestamentischer Zeit, III.* Hauptteil, Kap. 1-3 (Munich, 1981), pp.355-91.

24 Ezra 2:10, 36, 41, 65 and 3:10; Neh 7:39, 44, 67, 12: 27, 35, 41.

25 *Antiquitates XI*, 3, 10; 4, 2.

26 M Arakhin 2,3; Sukkah 5,4

27 McKinnon, J.'The Exclusion of Musical Instruments from the Ancient Synagogues', in *Proceedings of the Royal Musical Association*, 1979/80, p. 77.

28 *Encyclopedia Judaica*, vol.12:565.

29 Werner, E.,'Die Musik im Alten Israel', in: *Neues Handbuch der Musikwissenschaft*, ed. C. Dahlhaus (Laaber, 1989), p.90; H. Seidel, *Musik in Altisrael* (Frankfurt-Main-Paris, 1989), p.159.

30 Braun, *Die Musikkultur...*, pp.142-143.

31 Hos 9:1; Isa 25:8. In 1993 (Eds. Crown, A., Pummer, R., and Abraham, T., Tübingen 1993, p.163) denies any instrumental music in Samaritan music culture. The 2NGD (2001) entry on Samaritan music starts with the sentence 'Samaritan music is an oral tradition, sung at synagogue services and at other religious and social gatherings'(vol.22:201), and the expert of Samaritan music Prof. Ruth Katz does not mention in her publications Samaritan instrumental music even as possibility (Katz, R., 'Samaritan Music', in: *The Samaritans*, ed.. Crown, A., Tübingen, 1989, pp.743-70; reprint from Yuval 3, 1974: 109-35).

32 The first discussion on Samaritan instrumental music see in: Braun, *Die Muskkultur...*, pp.192-200.

33 Eg, Israeli Y. and Avida, U., *Oil Lamps from Eretz Israel* (Jerusalem, 1988), Nr.394.

34 Tcherikover, V. A., *Corpus papyrorum Judaicarum*, vol.1, (Cambridge, 1957), p.171.

35 See Zaqzuq, A.R./Duchesne-Guillemin, M., 'La Mosaïque de Mariamine', in: *Annales archéologiques arabes syriennes*, xx/1-2, pp.93-125 (1970).

Illustrations

1 The Megiddo harp etching (IAA 38.954) 1a and 1b: Megiddo harp etching: (a) correct, (b) incorrect (see footnote 6)

2 Prof. John Kenny's reproduction of the Megiddo harp

3 Cycladic harp player (see footnote 10, Van Schaik, fig 3) 4a and 4b: (a) Abchasian harp ayum'a, and (b) Yakutian top-saplyukh harp player (see footnotes 14 and 16)

5 Large cymbals.

6 Small cymbals.

7a and 7b: (a) terra-cotta lamp with depiction of double aulos and lyre (collection and photo of Dr. Broshi, M.); (b) terra-cotta lamp with depiction of organ and crotala (IAA 71.5080)

8 terra-cotta figurine with lyre on shoulder (Harvard Semitic Museum 907.64.474)

9 Map of Samaria

Abbreviations

AIP - Ancient Israel/Palestine *Atlas of...* - Vertkov, K., Blagodatov, G. and Jazovitckaya, E., *Atlas of Musical Instruments of the Peoples Inhabiting the USSR* (Moscow, 1975)
BA - Biblical Archaeology (Atlanta, USA)
BAR - Biblical Archaeological Review (Washington DC, USA) *eg.* – example given.
IAA - Israel Antiquity Authority
M - Mishnah
1MGG - Musik in Geschichte und Gegenwart, (Kassel-New York, 1949-1979).
2MGG - Musik in Geschichte und Gegenwart, Sachteil, (Kassel-Weimar, 1994-1998)
1NGD - The New Grove Dictionary of Music and Musicians, edited by Stanley Sadie (London, 1980)
2NGD - The New Grove Dictionary of Music and Musicians, Second Edition, Edited by Stanley Sadie (London-New York, 2001).
OBO – Orbis Biblicus et Orientalis, edited by Keel. O. and Uelinger, Chr, (from 1971- , Freiburg, Schweiz)

FOUR TABLES FROM THE TEMPLE LIBRARY OF NIPPUR: A SOURCE FOR PLATO'S NUMBER IN RELATION TO THE QUANTIFICATION OF BABYLONIAN TONE NUMBERS

Richard J Dumbrill

The four cuneiform texts discussed in the present paper were published in 19061 by Hilprecht, in his twentieth volume of the Babylonian Expedition of the University of Pennsylvania. The texts came from the temple library of Nippur and were part of some 7000 texts and fragments which he catalogued. The references to the four tables discussed in this paper are as follows: 20, Rev.; 21, Rev.; 22, Obv. and 24, Rev. They date from about 2200 BC. (Tables I-IV).2

Hilprecht writes that the texts were tables of multiplication and division. However, the purpose for these peculiar operations was not fully understood, because four texts of musical theory which were essential to their elucidation (UET VII 74 and 126; CBS 1766 and 10996) had not yet been satisfactorilyinterpreted. Thus the purpose for the tables remained obscure until now.

Hilprecht saw similarities with 'Plato's number', as laid out in Republic, Book VIII3, but he did not perceive that the missing numbers were the key to the understanding that the texts were about music theory.

This thesis is constructed from the premise that these omissions can only relate to the systems exposed in UET VII 74; UET VII 126; CBS 1766 and CBS109964, to the exclusion of any other.

As judiciously observed, Hilprecht noted that the four tables shared three particular features:

1. The highest number begins the series.
2. The numbers multiplied are not consecutive. They are often separated from each other by comparatively large intervals. (Note the absence of 7; 11; 13; 14; 17; 19; 21; 22; 23; 26; 28; 29; 31; 33; 34; 35; 37; 38; 39; 41; 42; 43; 44; 46; 47; 49; 51; 52; 53; 55; 56; 57; 58; 59; 61; 62; 63; 65; 66; 67; 68; 69; 70; 71; 73; 74; 75; 76; 77; 78 and 79.)

Out of 81 numbers, only 30 are listed.

3. Besides 3 and 5, no indivisible number or its multiple is multiplied.

Hilprecht collated the four tablets into one table which threw considerable light on its musicological significance:

1	8.640.000 A-AN	25	518.000
2	6.480.000	27	480.000
3	4.320.000	30	432.000
4	3.240.000	32	405.000
5	2.592.000	36	360.000
6	2.160.000	40	324.000
8	1.620.000	45	288.000
9	1.440.000	48	270.000
10	1.296.000	50	259.000
12	1.080.000	54	240.000
15	864.000	60	216.000
16	810.000	64	202.500
18	720.000	72	180.000
20	648.000	[80	162.000]
24	540.000	[81	160.000]

They all have 12,960,000 (= 604 and 36002) as their dividend. Hilprecht attempted at finding a reason for this number and found some answers with Plato's Republic, Book VIII, 546, B-D.

It seems that Plato adapted the numerological-mythological basis of a much older Babylonian story for his own purposes, without revealing his sources. The construction of 'his number' is based on the Pythagorean triangle. This right-angled triangle has two sides with ratios of 3 and 4 with a hypotenuse of 5. The addition of the cubes of each of the sides gives: [33+ 43 + 53 = 216]. Plato says that this is the number of days for a woman's shortest estation, and that 270 days, amounting to 9 months, is the longest gestation.

The surface of the triangle is [3 x 4 ÷ 2 = 6]. The multiplication of the three sides of the triangle gives [3 x 4 x 5 = 60]. Now 602 = 3600; 603 = 216.000 and 604 = 12.960.000. This is the famous number to which Plato wants to relate all in the universe.

Plato says that there are four principal varieties of states: timarchy which is made up of the Cretan and Laconian states; oligarchy; democracy and tyranny. The character of the states is determined by their individuals. There are five leading types of characters: the aristocratic; the timarchical; the oligarchical; the democratical, and the tyrannical. Timarchy comes from aristocracy through constitutional changes originating from disagreements between the ruling classes. The muses are asked to explain how discord started. They say that everything has a beginning and an end; even the ideal city will perish. However, the cause of decay, which does not belong in the ideal city itself, must come from outside. But always, degeneration starts by badly planned marriages and births. Things have not changed much.

Plato makes up a number which he says comes from the duration of a woman's shortest period of gestation, that is 216 days. From this number, he ends up with 12.960.000. He calls this figure the 'Lord of Better and Worse Births'. In fact it is the numeric form of a 'Great Law controlling the Universe', or the answer to all. The divine being whom Plato calls 'The World brought from Chaos to Order' has a number defined by the duration of its creation. The human being has a period of gestation defined by the first number, after the unit, in which root and square increase: This is the multiplication. It comprises three elements: length; width and thickness. It has four limitations which are the points by which the three dimensions are determined, thus rendering all things tangible and comparable: 3 x 32 (= 33 = 27) + 4 x 42 (= 43 = 64) + 5 x 52 (= 53= 125) = 216); two of which (numbers to be cubed,) namely 4, 3 (forming two of the three sides of the Pythagorean triangle), coupled with 5 (by multiplication, *i.e.,* 4 x 3 x 5 = 60) furnish two harmonies when three times increased (*i.e.,* three times multiplied by itself, therefore 60 x 60 x 60 x 60 = 12,960,000) - the one equal an equal number of times (*i.e.,* a square number), so many (= 36) times 100 (= 36002), the other of equal length one way, but oblong: on the one side, of one hundred squares of rational diameters of five (i.e., the nearest rational number to the real diameter of a square whose side is five, *i.e.*, to $\sqrt{50}$ = 7; for $\sqrt{49}$ = 7), diminished by one each (i.e., (49 [= 72] x 100) – (1 x 100) = 4900 - 100 = 4800), or if from irrational diameters (of five), diminished by two (each) (*i.e.,* 50 x 100 – 2 x 100 = 5000 - 200 = 4800), on the other hand, of 100 cubes of 3 (*i.e.,* 100 x 33 = 2700; the second harmony is therefore 4800 x 2700).

The two harmonies Plato gives with 60 x 60 x 60 x 60 (i.e., 36002 and 4800 x 2700, both = 12,960,000) represent two recurrent aeons in the life of the universe, in which the world waxes and wanes alternately. The harmony 36002 measuring the cycle of uniformity, and the harmony 4800 x 2700 is the cycle of dissimilarity. It goes without saying that the number 3600 rests upon the Babylonian sexagesimal system. Since Plato constructs his number from the shortest period of gestation, it may be inferred that it stands in a mathematical relation to other numbers. Since the smaller number refers to days, it is safe to interpret 12,960,000 also as days. Now 12,960,000 days, expressed in years, 360 days counted per year, are equal to 36,000 years. We know from Berossus, writing in the third century BC, that a period of 36,000 years, constitutes the 'Great Platonic Year', in early astronomical treatises, and that this was also the duration of a Babylonian cycle.

The Platonic number 12,960,000, which amounts to a period in the lifetime of the Earth, is called the 'Lord of Better and Worse Births.' In what sense this number, which is the square of the highest Babylonian figure determines good and bad births, has been explained in various ways. In the early stages of the cycle of 36,000 years, before disintegration and dissimilarity, nature produced better children than later. This was because the universe was growing worse. But this interpretation is not sufficient. Evidently Plato wants to bring out the double idea firstly that through the ignoring of a fundamental law of the universe at some early time, disagreement arose, followed by a subsequent degeneration of the whole human race; and secondly that the same fundamental law still governs the universe, and that its breach at any time is accompanied by the same result. Although it is true that births at a later stage of our cycle of 36,000 years are comparatively worse than those at an earlier period, the former are by no means of equal value. On the contrary, in Plato's words: 'Whenever our guardians promote marriages inopportunely, the offsprings cannot be well provided.', necessarily implies that whenever the guardians observe these principles, the children born will be healthy and prosperous. Thus good births are not confined to an earlier stage of the life of the universe and bad ones to a later one, but that good and bad births may occur at all times within our cycle. Whether a birth is good or bad is determined by the number 12,960,000, which for this reason is called 'Lord of Better and Worse Births.' The meaning of Plato's words, therefore, can only be that in order to be a good birth, the birth of a child must stand in a certain relation to 12,960,000, as the arithmetical expression of a fundamental law of the universe.

The answer as to how this number can influence the birth and future of a child lies within the Babylonian concept of the world. The universe and everything within, whether great or small, is created and ruled by the same fundamental law. The same forces and principles which rule the world's macrocosm, also rule man's microcosm. It is the purpose of astronomy to prove this harmony, and to determine the laws of invariance which rule the universe. The sky, from which the gods reveal themselves, is the great book, the 'Writing of Heaven', in which 'they' have written the whole story of heaven and earth, its past, present and future. The astronomer studies and deciphers this divine writing, the astrologer interprets its meaning with regard to the life and affairs of man.

According to this concept, all on earth, including the state and the family; the temples and cities of Babylon, are fashioned from heavenly patterns; and all human knowledge and science, including mathematics and astronomy, even the number itself, the division of the circle into 360 degrees, the calendar, the system of measures and weights, and the laws of music are all of divine origin. Seven, eleven and thirteen are not divisors of 12,960,000, and to this day are still regarded as unlucky numbers.

The Pythagorean right-angled triangle has sides which measure 3, 4 and 5.

Therefore they have 3:4:5 as ratios between them. The ratio of 5:6 is made up from the doubling of side 3

in relation to the hypotenuse. Ratios of 1:2 and 2:3 arise from the halving of 4. Thus we have 1:2; 2:3; 3:4; 4:5 and 5:6. These ratios correspond to the first divisors in Hilprecht's reconstruction. However, the divisor '1' should relate to 12.960.000, and not to 8.640.000 whose divisor should be 11/2. Hilprecht was concerned by this discrepancy and writes: 'I am unable to explain this strange phenomenon. Possibly we have to regard it as an abbreviated expression well understood by the Babylonians'. I do not see, either, any reason for this other than an irrational one, or, as Crickmore puts it to me, in a recent communication: '...could line one, for example, be a concession to practical musicians, who are not generally noted for their mathematical expertise? Or, could it be a reminder for theoretical musicians that the whole of these tables can have an application in a musical context? Or is it simply the scribe's dedication of the table to Ea, the 'god' of music?' Indeed, if we read the sign šuššu, = 60, Anu's number, referring to the musical string of 60 ubanātu, then 60 x 2/3 = 40, which is Ea's number.

The Neo-Babylonian text UET VII, 1266, published by the late Professor O.R. Gurney, shows that in l.47 a fourth-string is listed, bilingually, as Sumerian 'sa.4.tur' = 'fourth, small-string', and Akkadian 'a-ba-nu-[ú]' = 'Ea-created'. It is the only string, with a god relationship, mentioned in the text. The pairing of Ea with this fourth string whilst the god is usually associated with number 408 attracted my attention. Might there have been an earlier numbering of the gods where only the leading deities were listed as: 6 for Anu; 5 for Enlil; 4 for Ea; 3 for Sin and 2 for Šamaš, whilst they are usually known as 60; 50; 40; 30 and 20, respectively. The ratios between them would be: 6:5; 5:4; 4:3; and 3:2. In the sexagesimal musical scale, the ratio of 6:5 is the minor third; the ratio of 5:4 is the major third; 4:3 is the fourth and 3:2 the fifth. These constitute the essential intervals of the Babylonian musical system as we know it from CBS 10996 where they are clearly defined although restricted within a heptachordal system which accounts, as a consequence, for thirds inversed into sixths and fifths inversed to fourths. The text mainly names intervals in function of their position in the following pattern: 1-5/7-5; 2-6/8-6; 3-7/9-7, etc. (in fact the pattern being restricted to the heptachord reads: 1-5/7-5; 2-6/1-6, etc.) The divisors for these intervals are 2-3, for the interval of the fifth and 6-5 and 5-4 for minor and major thirds, respectively.

UET VII, 126 lists strings in a particular manner showed below (Fig.1) which explains a tuning method devised for an enneatonic system, a forerunner for the heptatonic model. The tuning starts from the central note which is the tonic-central note from which fifths, rising and falling, make up the enneatonic span. Fourths rise and fall from the extremities. Thirds, minor and major appear as a consequence. It follows that the range of divisors resulting from this method is placed between the Nippur numbers 36 and 80: 36; 40; 45; 48; 54; 60; 64; 72; 80. Not only all of these numbers are divisors in Hilprecht's reconstruction, but the missing numbers in his table are also absent from the pattern in UET VII 126. It is obvious that this cannot be taken as purely coincidental. Significantly, UET VII 126 has 80 as its highest number. The smallest interval produced by the divisors also ends Hilprecht's reconstruction, with the ratio of 80:81. This is the syntonic comma also known as Ptolemaic comma or comma of Didymus, and measures 22 cents.

CBS 17669 produces a generative scale which finds its place within the divisors 27 and 48 as: 27; 30; 32; 36; 40; 45 and 48 whilst the enneatonic system in UET VII 74 places its tones within the range of 25 to 50 with the following divisors: 25; 27; 30; 32; 36; 40; 45; 48 and 50, in the enneatonic, and between 27 and 48 in the heptatonic. Here again, these scales use all of the numbers present in Hilprecht's table to the exclusion of any other.

Conclusion

None of the texts of music theory discovered so far have produced any tone number which is not produced in Hilprecht's table. Each number corresponds to a Babylonian pitch. Because of their particular structure, the Nippur texts were tables listing the full range of tone numbers known to Babylonian music theory. The other columns where the numbers are in the form of n2; n3 and n4 provide with the quantification for more sophisticated intervals such as will be revealed in centuries to follow, notably with Plato's 'two harmonies' which is precisely located in the n3, in the range 2700; 3000; 3375; 3600; 4000; 4320; 4500 and 4800. In the 6th century AD, Boethius, as a keen Neo-Platonist, uses numbers in the Nippur tables, and so do later theoreticians such as Farabi, Avicenna, Safi ad-din, Salinas and many more. To this day, the figures in the Nippur tables still constitute the basis for the study of music theory (Fig. 2).

Notes

1 Hilprecht, H.V., The Babylonian Expedition of the University of Philadelphia – Series A: *Cuneiform Texts*, (Hilprecht, ed.) Volume XX, Part I Published by the Department of Archaeology, University of Pennsylvania (1906)

2 Hilprecht, H.V., *The Babylonian...*, Pls 10; 11; 12; 14; CBM 11340 + 11402; 11368; 11902; 11097.

3 Adam, J., *The Republic of Plato, Book VIII*, appendices, pp. 264-318. (Cambridge, 1902)

4 Dumbrill, R.J., *The Archaeomusicology of the Ancient Near East* (Victoria-Oxford 2005) pp. 11-110.

5 Hilprecht rightly notes that: 'They all read: 1 - 8.640.000 A-AN. The quotient being 2/ 3 of 12.960.000, we should rather expect '1 ½' instead of '1' as its divisor, for 12.960.000 divided by 3/ 2 = 12.640.000 x 12.960.000 x 2/ 3.'

6 Best identified as a Late Babylonian manuscript of tablet XXXII of the text Nabnītu. See Finkel, I.L., *Materials for the Sumerian Lexicon (MSL)* XVI, 251; Wulstan, D., The Tuning of the Babylonian Harp, *IRAQ* XXX, (1968), 215-228; The Earliest Musical Notation, *MUSIC AND LETTERS 52*, (1971), 365-382; Duchesne-Guillemin, M., A Hurrian Musical Score from Ugarit: The Discovery of Mesopotamian Music, *SANE*, Vol. 2, Fasc. 2, (Malibu 1984) 5-24; Survivance Orientale dans la désignation des Cordes de la Lyre en Grèce, *SYRIA* 44, (1967), 233-246; A l'aube de la Théorie Musicale: Concordance de Trois Tablettes Babyloniennes, *REVUE DE MUSICOLOGIE 52*, (1966), 147-162; Crocker, R., and Kilmer, A.D., The Fragmentary Text from Nippur, *IRAQ* XLVI, (1984), 81-85; A Music Tablet from Sippar, *IRAQ* XLVI, Part 2, (1984), 69-79; Vitale, R., La Musique Suméro-Accadienne, *UGARIT-FORSCHUNGEN*, (1982), 241-263; West, M.L., The Babylonian Musical Notation and the Hurrian Musical Texts, *MUSIC AND LETTERS*, 75/4, (1993), 161-179; Dumbrill, R.J., Babylonian Theonumerics and Scale Systems, *JAC*, Volume 22, 2007.

7 Having read the manuscript of the present paper, Prof. Andrew George brought to my attention that the 4th line of the Akkadian column of Professor O.R. Gurney's VIIth tome of the *Ur Excavation Texts* (1973), Pl. LX, only shows 'a' and not '*a-ba-nu-[ú]*' (Kilmer), or A.DÙ (Finkel), I wrote to Gurney who replied to me that the tablet, now in Baghdad, read *a-ba-nu-[ú]* but that inadvertently had left *ba-nu-[ú]* out. The error is corrected in *IRAQ* XL, VI, 82, fn. 1.

8 Röllig, W., *REALLEXIKON DER ASSYRIOLOGIE* sub Götterzahlen, p. 499-500; Livingstone, A., *Mystical and Mythological Explanatory works of Assyrian and Babylonian Scholars*, (Oxford, 1986), , 30-49; Parpola, S., The Assyrian Tree of Life: Tracing the Origins of Jewish Monotheism and Greek Philosophy, *JNES*, 52, n. 3, (1993), 182-184, fn. 86-89.

9 Waerzeggers, C., and Siebes, R., 'An alternative Interpretation of the seven-pointed star on CBS 1766 (Horowitz, *JANES* 30) *N.A.B.U.*, 2007, no.2, June, pp. 43-45; Dumbrill, R.J., forthcoming; Crickmore, L., forthcoming.

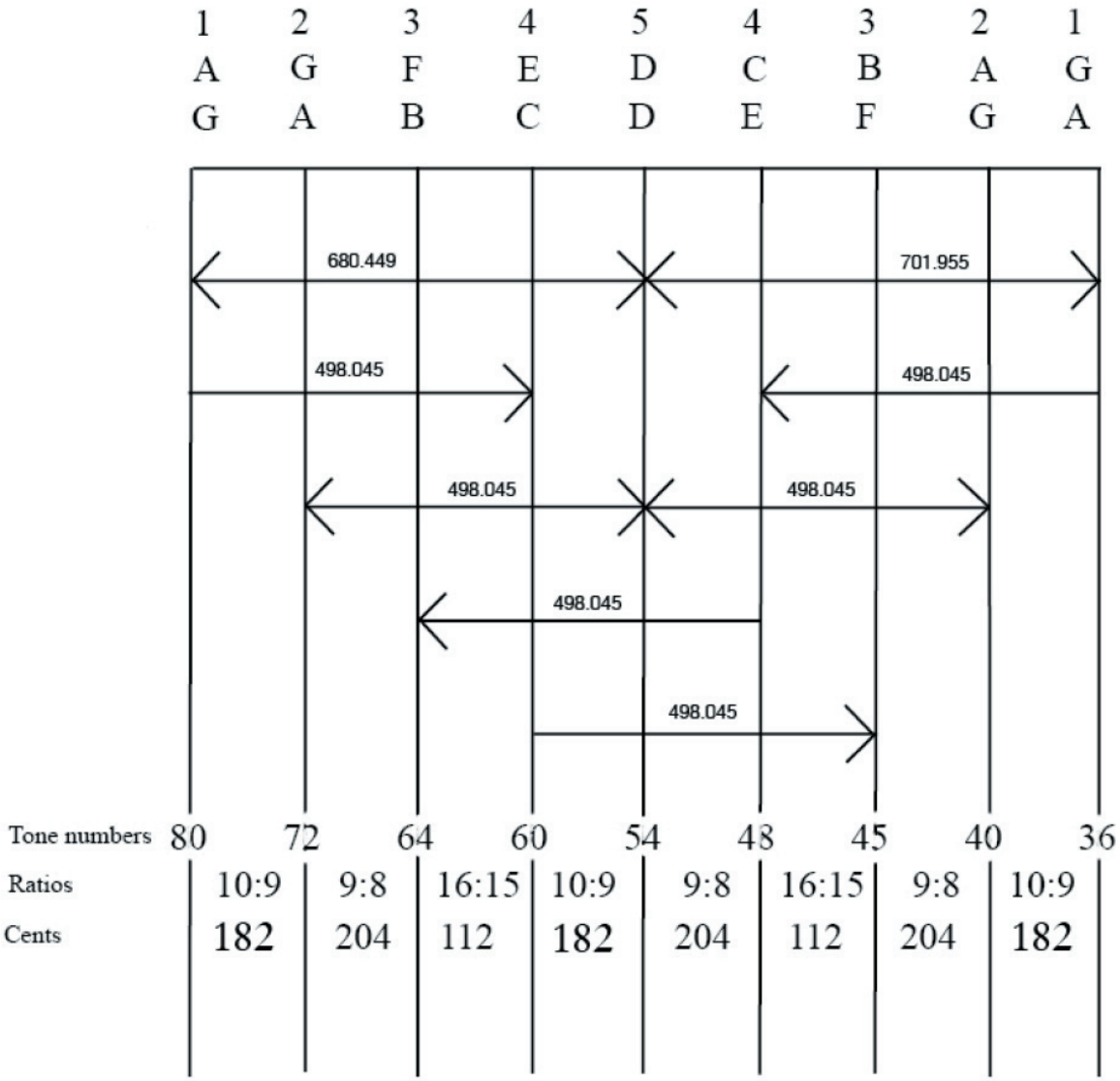

Fig.1. Diagrammatic rendition of UET VII, 126

Nippur 60^4	Divisor	Pitch	Pitch	Cents	Ratio
12.960.000	[1]	F	B		
				701.954	2:3
8.640.000	$[1^{1/2}]$	C	E		
				498.045	3:4
6.480.000	**2**	F	B		
				701.954	2:3
4.320.000	**3**	C	E		
				498.045	3:4
3.240.000	**4**	F	B		
				386.314	4:5
2.592.000	**5**	A	G		
				315.641	5:6
2.560.000	**6**	C	E		
				498.045	8:6 = 3:4
1.620.000	**8**	F	B		
				203.910	8:9
1.444.000	**9**	G	A		
				182.404	9:10
1.296.000	**10**	A	G		
				315.641	10:12 = 5:6
1.080.000	12	C	E		
				386.314	12:15 = 4:5
864.000	**15**	E	C		
				111.731	15:16
810.000	**16**	F	B		
				203.910	16:18 = 8:9
720.000	**18**	G	A		
				182.404	18:20 = 9:10

Fig.2. Musicological rendition of Hilprecht's tables

648.000	**20**	A	G		
				315.641	20: 24 = 5:6
540.000	**24**	C	E		
				70.672	24:25
518.000	**25**	C#	Eb		
				133.237	25:27
480.000	**27**	D	D		
				182.404	27:30 = 9:10
432.000	**30**	E	C		
				111.731	30:32 = 15:16
405.000	32	F	B		
				203.910	32:34 = 8:9
360.000	**36**	G	A		
				182.404	36:40 = 9:10
324.000	**40**	A	G		
				203.910	40:45 = 8:9
288.000	**45**	B	F		
				111.731	45:48 = 15:16
270.000	**48**	C	E		

Fig.2. Musicological rendition of Hilprecht's tables (continued)

				70.672	48:50 = 24:25
259.000	50	C#	Eb		
				133.237	50:54 = 25:27
				182.404	54:60 = 9:10
216.000	**60**	E	C		
				111.731	60:64 = 15:16
202.500	**64**	F		B	
				203.910	64:72 = 8:9
180.000	**72**	G	A		
				182.404	72:80 = 9:10
62.000	**80**	A	G		
				21.506	80:81
160.000	**81**	A*	G*		
144.280	**90**	B	F		

Fig.2. Musicological rendition of Hilprecht's tables (continued)

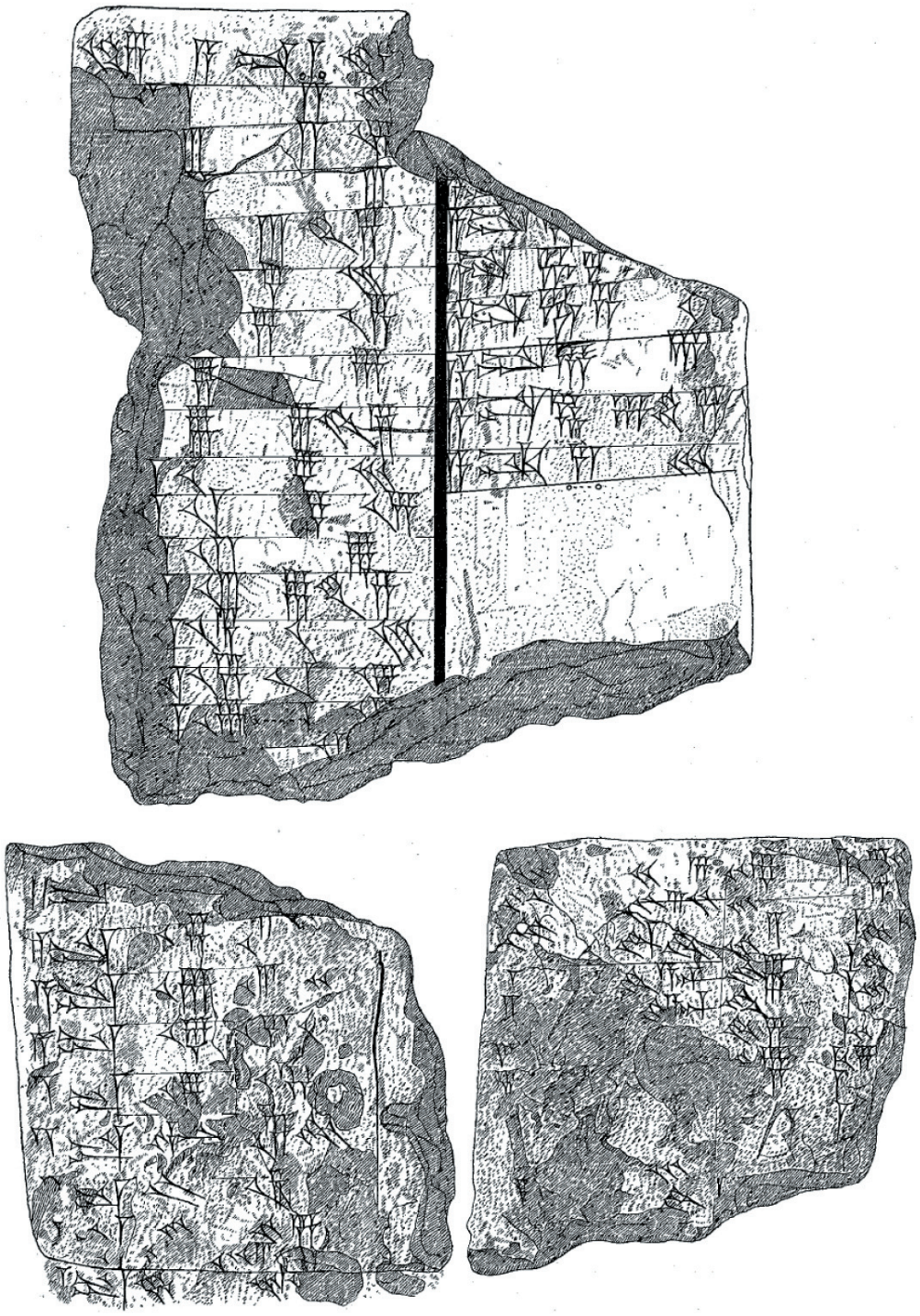

Table I. 20 Obv. CBM 11340 + 11402; 21 Obv. and Rev. CBM 11368

Table II. 20 Rev. CBM 11340 + 11402

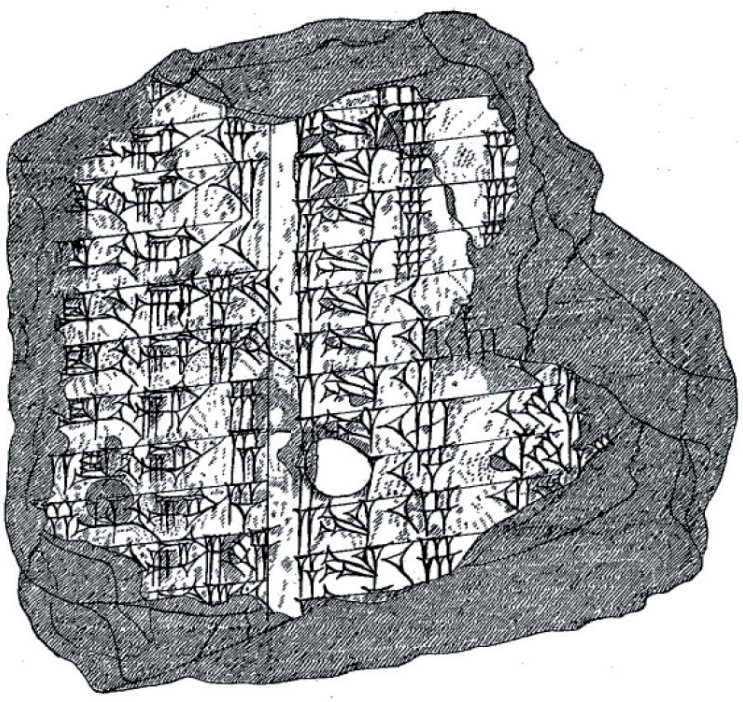

Table III. 22 Obv. CBM 11902

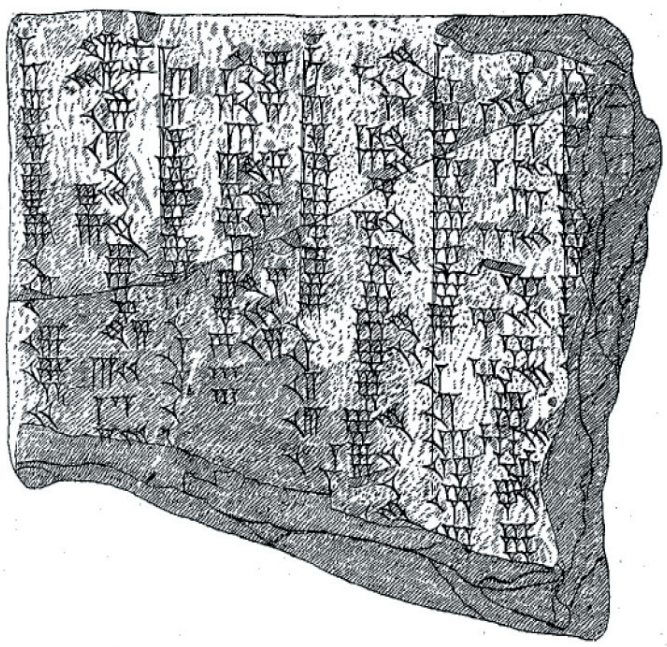

Table IV. 24 Rev. CBM 11097

N.160
PRN:WCO26834
Excavated by: Sir Austen Henry Layard (1848/51) Neo-Assyrian, 8th century BC
Site of excavation: Nimrud (*Kalḫu*), at the North West Palace

EMBODYING MUSICAL PERFORMANCES IN THE ANCIENT MEDITERRANEAN

Agnès Garcia-Ventura and Mireia López-Bertran

Music should be understood not just as the production of sound, but also as a combination of two or more factors. In many contexts, for instance, music is linked to dance (Kilmer, 1995: 2608-2611) and the playing of an instrument may be a performance in itself: an embodied practice. In this situation, bodies represent the link that bring music and these practices together.

In this paper we explore this interaction further by focusing on the role of music and sound in relation to the body. We take into consideration two main areas in our analysis of bodies as the main protagonists in the production of music. On the one hand, we consider dancing, pilgrimages, and the playing of instruments as performances realized through human bodies. On the other hand, we also conceive human sounds such as crying, singing or clapping as musical events in which the body itself is the musical instrument.

Our study is based on the description of a set of archaeological materials: masks, body ornamentation, terracotta figurines of humans (among them musicians) and musical instruments from a series of Phoenician and Punic ritual sites in Eivissa, Sardinia, the Iberian Peninsula, and Carthage, dating from the eighth to third centuries BC. As supportive evidence we include some materials from Ancient Near Eastern Cultures, which will help to elucidate various features that shape musical and auditive experiences.

Before addressing our main topic, we propose a reconsideration of some of the key terms that will concern us here, and present a set of working hypotheses that will help us to identify auditive phenomena in Antiquity and define their functions. The broadest term of all is 'sound'. As defined in the *Encyclopaedia Britannica*, sounds are 'the mechanical vibrations travelling through the air or some other medium at a frequency to which the human ear is sensitive'. Sound, then, is described as a phenomenon of physics: a series of vibrations. Music, on the other hand, is defined as 'art concerned with combining vocal or instrmental sounds for beauty of form or emotional expression, usually according to cultural standards of rhythm, melody, and, in most Western music, harmony.' Here music is described as emotion, that is, more than just a physical phenomenon. Consequently, and in spite of the difficulties in making a clear distinction between what is mere sound and what is music, we will equate sound with vibrations and music with sensations (Beament 2005: 1-5). Thus, insofar as it concerns 'humanly organized sounds' 'music' is a cultural phenomenon shaped by societies (Blacking 1973: 3-31).

Though we agree with the basic idea of the definition mentioned above, we think is also important, especially when approaching Ancient music, to stress that we are considering 'musical instruments' in a broad sense. The term includes 'any implement that can emit sound, from the use of raw materials such as wood, bone or stone, to the human body itself' (Watson and Keating, 1999: 325). Moreover we consider that material culture is dynamic (Appadurai 1986; Kopytoff 1986): objects are not static, but may have different applications depending on who uses them and for what end. So we search for other explanations for the existence of pottery in shrines: besides their traditional use related to cooking and eating practices, we consider alternative explanations regarding their acoustical properties. Clearly, this is the case of certain ceramics or shells, whose functions have been traditionally defined without considering their value as producers of sound or even as models for the development of musical instruments (Kilmer, 2002: 484). We also try to establish how these objects, especially the masks and terracottas, would have been used in ritual performances.

Acoustic properties can be attributed to bodies as well. In our view, bodies play an active role in the creation of music and sound: we regard them as agents in social dynamics and consider that our relation with the world has a corporeal dimension. In this process, the concept of embodiment is essential (Csordas 1994). This term focuses on the corporeal dimensions of human activities: we do not *possess* bodies so much as we *are* bodies. Our bodies not only express identities and social relations but construct them as well. In the domain that interests us here, bodies create music and sound both through their movement and through their decoration.

We also assume that music in Antiquity was an essential element in ritual performances, which were characterized fundamentally by their intersensoriality. As we will see, hearing is a key sense in Phoenician and Punic rituals. We should also bear in mind that music is a cultural phenomenon; so sounds that we do not generally regard as music, such as the whispering of the wind, or the crackling of fire, could be considered as music or sounds proper – especially in ritual contexts – because they act on the emotions. So music and the emotions are closely linked;

emotion, moreover, exerts an influence on the taking of rational decisions (Mithen, 2005: 2, 89 and 101).

Selected Materials: shrines and cemeteries from Phoenician and Punic cultures

The materials we have selected come from various sites. The first are two burial sites: the cemetery at Puig de Molins, a Punic town in Eivissa (Balearic Islands), and the various cemeteries at Carthage, Tunisia. The second group of sites comprises shrines from the Iberian Peninsula, Eivissa, and Sardinia. As we are interested in showing how music is embodied, we will not analyse each specific settlement in detail, but will present a thematic study of the information that these shrines provide. We will start with a brief description of the main features of each site.

Carthage has several graveyards. The Carthaginians first occupied the hills of Byrsa, Juno, Dermèche and the plain of Douimés between the eighth and fifth centuries BC. From the fourth century BC onwards, new cemeteries were created on other hills such as St. Monique and Odeon. In contrast to the common Phoenician model in which cemeteries were built outside cities, at Carthage all the graveyards were intramuros (Fantar 1995). From the mid sixth century BC onwards the grave goods are relatively homogeneous: the masks, protomae, jewellery, terracottas and some metallic and ivory objects are significant for our purposes.

Puig des Molins, in Eivissa, is located on a small hill (51 m above sea level) and separated from the Phoenician and Punic city by a river bed. We will concentrate on the materials dated between the mid-sixth and the fourth centuries BC. The grave goods do not follow a fixed model. In this paper, we consider only the material culture related to music and sounds: female terracotta figurines playing instruments, masks, small bells, jewellery, and razor-shells. Our second group comprises a range of Punic sanctuaries from the Iberian Peninsula, Eivissa, and Sardinia. Two of the shrines are in southern Iberia, on the Atlantic coast. La Algaida (Sanlúcar de Barrameda, Cádiz) is located in the Guadalquivir river marshes. In Ancient times it was an island, and the shrine was an open-air sanctuary with three small rooms, identified as chapels (Corzo 1992; Ferrer 2004). The material culture covers a long period (seventh to second century BC) and is accompanied by a large amount of ashes and organic remains. The objects we analyse are, basically, pottery such as oil-lamps, terracottas, jewellery, and organic remains such as shells.

Gorham's Cave is the other Iberian case-study. As its name indicates, it is a cave-sanctuary, located on the Rock of Gibraltar. Its placement is highly significant, at the meeting-point between the Mediterranean and the Atlantic, at the most dangerous point in the Atlantic route. The cave consists of a long corridor and has a large stalagmite at the entrance (Belén 2000; Belén, Pérez 2000; Gutiérrez López *et al.* 2001).

The Phoenician and Punic chronology dates from the eighth to the second century BC. The material remains are diverse; here we focus on the cave itself, oil-lamps, incense-burners, and cooking and eating vessels together with organic remains such as fauna and malaco fauna.

From Eivissa (Balearic Islands) we describe an open-air shrine (Illa Plana) and a cave-sanctuary (Es Culleram). Although today Illa Plana is on solid ground, during the Phoenician and Punic occupations it was an island in the middle of the bay of Eivissa, not far from the harbour. Illa Plana has been defined as a sacralized natural site because no structures have been found, though there are two votive-deposits. One pit contained only several human terracottas, dated between the end of the sixth and the middle of the fifth centuries BC. We will study these figures carefully in relation to music and sound.

Es Culleram is a cave-sanctuary on the southern hillside of the San Vicente valley. The cave is divided into three main spaces and has a cistern at its entrance. It was used between the fourth and the second centuries BC, reaching its highest point of activity during the third. A large number of materials have been found, but the ones that interest us most are some terracotta figurines, pottery, and the cave itself.

Moving to Sardinia, we describe some human terracottas from two votive deposits which were associated with sanctuaries: Neapolis, on the west central coast of Sardinia, and Bithia, on the south coast, which are dated between the fourth and the first centuries BC (Moscati, 1989; Uberti, 1973). The figurines from these sites are useful examples for the analysis of topics related to music and body.

Dancing and music

Dance is an important element in religious ceremonies. Unfortunately, no direct evidence of the practice remain, but we do have some indirect evidence: the masks found in graveyards, and some human figurines who appear to be dancing. It is not easy to interpret the figurines as dancers due to the technical problems involved in representing movement in static supports such as pottery (Garfinkel, 2003: 18). However, other products of the Phoenicio-Punic culture also present references to music in funerary contexts: depictions of dances in funeral paintings, and descriptions by some classical authors of the presence of musicians in the Carthaginian Tophet (Fantar 1993, 324 and 223).

Masks are commonly found in the cemeteries at Carthage and Puig des Molins and they have been interpreted as proof of dancing (Bénichou-Safar 1982, 267). They are not found on the face of the deceased, but next to them (Picard 1966, 10). Their size and the presence of holes suggest that these objects may have been placed on the face in order to perform a ritual before they were deposited

as grave goods, and this ritual might be related to dancing. Masks and dancing are two elements closely involved in achieving altered states of consciousness or euphoric excitement. Many masks represent faces in unnatural poses: they have large, open eyes and mouths and are traditionally interpreted as demonic or satirical representations. Dancing, together with music, stimulates hyperventilation, raises adrenaline, and lowers sugar levels – all conditions that may cause altered states of consciousness. Hyperventilation, exhaustion, whirling, turning and circular and rotational movements all affect the sense of balance and equilibrium and may eventually cause dizziness (Garfinkel, 2003: 42), so the presence of masks representing unnatural faces may be showing the trancelike properties of dance. Besides, some of these masks are decorated with earrings or scarifications, and body decoration has been considered one of the common features of dancers in Antiquity, especially in the Middle East. So masks are not passive materials, mere dedicated objects, but elements of embodied ritual practices.

During these states the intensity of the experience is more important than its duration, a phenomenon denoted as 'ritual time' (Blacking 1994, 78). This serves to emphasize the bodily dimension of religious rituals; they are not abstract entities, but practices created by the body. Human figurines are also useful in the analysis of the association between music, dancing, and rituals. Here we will describe two kinds of terracotta. Figurines of cymbal and flute players are found in both our cemeteries (Carthage and Puig des Molins). Cymbal players emphasize not only the role of music, but the role of dancing as well. In many cases, they are represented as dancing, through the movement of dresses and legs; it seems natural that musicians dance or follow the rhythm while they are playing an instrument. Together with dancing, the sound of cymbals might also induce altered states of consciousness. It has been demonstrated that intensive and repetitive percussion rhythm overstimulates the senses, another way of inducing altered states of consciousness (Angrosino 2004; Pollack-Eltz 2004). Besides, the sound of cymbals has been attributed purifying properties and was believed to ward off evil spirits (Bénichou-Safar 1982, 270). This point is particularly relevant in view of the existence of cymbals in the cemeteries at Carthage and Eivissa and the numerous terracottas of cymbal players.

Human figurines from the shrines of Illa Plana (Eivissa), Neapolis and Bithia (Sardinia) reflect other strategies to represent dancers in static supports. Although most of these materials are represented without legs and feet, the body decoration and the hands and fingers merit particular attention. As we have stated, the presence of necklaces or headdresses is proof of dancing, as this is a ritualized activity that requires special decoration. Indeed the presence or absence of decoration in our figurines is highly significant. Only a few figurines are decorated: as it is unlikely that all the participants in rituals were authorized to dance, it may be that the decorations identify the specific group, or elite, that was allowed to do so.

One of the most common ways of depicting dancing is the overrepresentation of hands and fingers, due to the communicative capacity of these parts of the body (Garfinkel, 2003: 26). In some of our figurines, the hands and fingers are presented in exaggerated forms. Although the mainstream interpretations of the presence of hands are related to touch as a way of healing (López-Bertran, in press – especially in the case of Bithia and Neapolis in Sardinia), this interpretation is compatible with dancing. Curative rituals in Antiquity are related to the idea of expelling evil spirits from the body, since illnesses are linked to the gods. Dancing is a very strong means of communicating with the gods and with evil spirits, and of creating an appropriate atmosphere for worship or for other religious activities (Martí, 2003: 309). So music and dance would have been performed together in ritual situations.

Pilgrimage and body decoration

Assuming that bodies are potentially producers of music and sound requires us to look at some ritual practices from an auditive point of view. The activities we will examine in this section are pilgrimages and sounds produced by humans when they are in motion.

One of the most common funerary rituals may well have been a march or procession bearing the deceased to the cemeteries of Carthage and Eivissa. In this march, music, walking and dancing would all have been significant activities as the musician terracottas and written sources suggest. In situations that involved funerary marches, walking would have been a vehicle used to create a religious or spiritual practice. To quote Slavin (2003, 9) 'walk becomes meditative as the body falls into a rhythm'. Walking in ritual contexts such as marches or pilgrimages creates a specific rhythm which influences the ways in which people experience spiritual events. When walking is accompanied by music, the rhythms of the two activities condition and complement each other. Indeed, processions were common in many Ancient cultures: in some Egyptian tombs, for instance, we find depictions of funerary processions accompanied by music (see the tomb of Djeserkarasonb, in Capel and Markoe 1996, 15). In this way, the physical and material practice of walking allows people to move into a non-material world. Again, we see how the religious rituals are embodied practices.

What role did body decoration play in these cases? Assuming that many of the figurines associated to funerary rituals are representing real people, the first point to note is the presence of elaborate decoration in the form of headdresses and jewellery (especially in the ones found in the cemetery at Puig des Molins). We can imagine the sounds of all this decoration when dancing, marching or playing

instruments, all of which are important to the creation of a ritual atmosphere. Possibly, percussion instruments were designed by the first humans taking as a reference the sound produced by their ornaments in their community/ communal/? movements (Beament 2005: 12).

Equally, the small bells found close to the deceased in both cemeteries are interesting for the analysis of how body decoration produces special sounds. Worn around the neck, these bells had a religious and prophylactic function as amulets (Fernández 1992: 197). Ringing a bell may have an apotropaic function (Martí 2003: 311): like playing cymbals, it may have been a way of warding off evil spirits and protecting the deceased in the afterlife. Thus, bells may well have been played before the burial.

Some Phoenicio-Punic shrines are also interesting with reference to these funerary marches defined as pilgrimages. Gorham's Cave (Iberian Peninsula) and Es Culleram (Eivissa, Balearic Islands) are sanctuaries in remote locations, some way away from settlements. So visitors would have gone there with a specific purpose in mind; that is to say, their journeys are ritualized, and can be defined as pilgrimages. The significance of this physical effort lies in the combination of a physical and a symbolic experience. As ethnological fieldwork has demonstrated, taking part in a pilgrimage becomes a spiritual and meditative practice, as the people concentrate solely on this action and its rhythm (Slavin, 2003).

These journeys involved not only walking, but navigation as well. In both cases, the pilgrims had to travel by sea to reach the sanctuary (Es Culleram is on an island, and Gorham's Cave, located in a remote area of the Rock of Gibraltar is also only accessible by sea). Considering maritime journeys as pilgrimages expands the traditional idea which links them with walking (López-Bertran et alii, 2008). In this connection, we consider any movement carried out at sanctuaries (sailing, dancing, or descending/?) potentially as a pilgrimage if it is performed with special connotations. Our approach to pilgrimage focuses on their embodied elements: in other words, people's movements and their sensual experiences.

These shrines are useful in the analysis of the role of the sounds produced by body movements as significant elements in ritual performances. Let us begin with caves. The echoes created by human sounds could be considered very special sounds, or even music, and a way of making contact with a symbolic world. Indeed, in some societies echoes are considered supernatural and are interpreted as the voices of spirits answering human inquiries (Purser 2002: 28).

The lack of visibility inside caves is likely to have made the other senses particularly important. At these sites, the sense of hearing would have been exploited in different ways. Gorham's Cave has a large number of incense-burners and oil-lamps, whereas Es Culleram has very few/none/?. Thus, hearing would have been an essential trait for orientating oneself in Es Culleram but not in Gorham's Cave. Both sites present a significant number of cooking utensils, eating vessels and faunal remains. The act of killing and cooking animals would have produced a range of special sounds: the cries of the animals, the crackle of the fire, the pounding of mortars, and so on. All may have had musical properties because they form part of a ritualized set of activities and are, in fact, 'humanly organized sounds'.

Performing music: instruments and players

Though our conception of music as a complex category includes other factors as well, it is undeniable that instruments and music-players are the key agents in the analysis of musical events in Antiquity. Phoenician and Punic cemeteries provide us with a wide range of representations of musicians and instruments. First of all let us describe the materials related to music from Puig des Molins (Eivissa, Balearic Islands, Spain) and Carthage (Tunisia).

At Puig des Molins we have found many terracotta figures of cymbal and double flute players (nine and two figurines respectively), although in many cases we do not know their exact origin. Among the razor-shells, there is one that represents a person playing a cymbal. Moving on to the cemeteries at Carthage, we find more or less the same situation: there are four terracottas of cymbal players and, as at Puig des Molins, some of the razor-shells have cymbal player representations. In the light of what we have said above, the finding of these materials suggests that music and sounds must have played an important role in performing funeral rituals.

Most of the musical instruments of Antiquity were percussion instruments (Mithen, 2005: 269), as borne out by the large number of terms used to differentiate between kinds of drum recorded in Sumerian lexical texts (MSL 7). In fact, they are closely related to the constitution of the human body: that is to say, from the beats of our heart to each one of our movements, our body is constantly creating rhythm.

Simple to build and to play, percussion instruments do not need a specific theoretical musical system. This feature would have had an important bearing on the role of music players in Antiquity. Due to the increasing complexity of both instruments and instrumental music since the Renaissance, music players have been considered as specialists in performing music (Fubini 1996: 134-135): not only do they play music, but they interpret it. There was a transition from a mainly physical task to an intellectual one. If we think of music in Antiquity, when there were no complex instruments, it seems likely that the people who played instruments were considered specialists due to their skill, not due to their intellectual or interpretative abilities.

The body as a musical instrument: singing, clapping and crying

Most of the terracottas from Neapolis, Bithia (Sardinia, Italy) and Illa Plana (Eivissa, Balearic Islands, Spain) have large, open mouths; it is as if they were singing, praying, or mourning. The human voice is one of the oldest Ancient musical instruments. Some scholars link the first stages of language with the first stages of music, abilities that emerged in humans many thousands of years ago (Mithen 2005: 28-61 and 195). Others, more critical of the classical assumption of the voice as the first musical instrument, reflect on the danger of singing during or after hunting activities: until the society had a sufficiently advanced system of self-protection, singing was an unlikely activity (Beament 2005: 12). On the other hand, despite the impossibility of stating conclusively which came first, the imitative mechanism of the human voice suggests the possibility that the first creation of sound-producing artefacts imitated the voice and not vice versa, as is usually believed (Beament 2005: 54-57).

Whatever its origins, singing is a way of preserving traditions, of transmitting ideals and education (Blacking, 1994: 70-71), of lamenting and communicating. As a communicative device, singing might have accompanied ritual performances and might have played an explanatory role. For the first stages of the communication between mother and infant, singing is a universal resource: lullabies have been common among a great variety of societies through the ages (Mithen, 2005: 72-79).

The ability to sing, and more precisely the ability to sing well, was highly valued in Ancient Egypt and was an activity mainly performed by women (Watterson, 1998: 47-49). In the cuneiform as well, such as Ebla or Mari texts, many women are listed as singers, though, in some cases, this word was also used as a euphemism for prostitutes (for Ebla texts concerning women's roles, see Biga, 1987 and 1991).

Another circumstance that is important to our reflection on singing is the possible individual or community dimension of the performance itself. Usually we listen to one person singing alone – for example, soloists in an opera, or choirs of many people singing at once. What is less usual in our times is for an audience to sing in accompaniment with people considered as specialist singers. Not so long ago, however, this would have been no surprise: in the eighteenth century there is evidence that in choral concerts both the singers and the public would sing (Martorell 1996, 142). Although we must consider all the possibilities in the contexts we are analysing, in our view collective formulas may have been more common, because of their role in reinforcing the community and clapping may have produced the same effect. Some terracottas from our sites mentioned are also presented with the two hands together, perhaps representing the act of clapping, which would be a clear example of the use of parts of the body as musical instruments. In Ancient Egyptian paintings and reliefs we also find groups of women clapping their hands (see the tomb of Queen Nefru, at Deir-el-Bahri). This manual function was also captured in the form of musical instruments: some banging sticks from Egypt represent arms with hands (Ziegler, 1979: 25-26). Together with clicking the fingers, clapping the hands would have been a common way of keeping the rhythm in rituals (Capel and Markoe, 1996: 94).

The repetition of these sounds, as is the case with the sounds produced with ornaments when a group is walking, tends to be synchronized, reinforcing the feeling of community membership. Each movement, each hand clapping creates a particular atmosphere, a ritualized one, as happens today in a concert or a performance where the synchronized applause of the audience becomes a collective performance in its own right (Beament 2005: 139-146).

The act of crying was specifically related to funerary settings. The practice is associated above all with mourning women: in Ancient Egypt (Capel and Markoe 1996, 15; Watterson 1998, 45-46), Greece, and in many societies today, women are specialized in lamenting death. This fact is also of relevance to our study, because performing the same activity over long periods may induce altered states of consciousness.

Another explanation of the specialization of women as mourners is their association with activities related to the maintenance, creation, and recreation of life (Picazo 1997). Seeing death as the last step of life, and bearing in mind that it is women who give birth and who take exclusive care of children in many societies (Murdock and Provost 1973), it is easy to accept that they should be responsible for the public ritual of lamenting the dead. This could explain why most of the musicians related to funerary rituals are women, while in other contexts the same instruments are depicted as being played by both men and women (Watterson 1998, 51).

Conclusion: engendering music

Since the instrument players represented in funerary contexts are always women, these terracottas are useful to analyse the relation between gender and music. Some scholars have interpreted them as representations of the goddess Astarté, because cymbals are one of her attributes, and moreover she is a protector of the dead (Ferron, 1969: 19 and 23). Nevertheless, we consider them to be mortal women, perhaps with a specific role: in any case, people of high rank. In the Phoenician and Punic studies the roles of women have not been studied in depth, and their relation with music is no exception.

The women represented in these terracottas (and others without instruments) should be studied in terms

of corporeality. First of all, they may have had a specific ritual function during the performance. Two possible roles are as priestesses or matrons. It is natural to define these figures as priestesses, for two reasons: on the one hand, in many societies having a religious function requires musical knowledge; this is particularly clear in Mesopotamia, where musicians were members of the temple staff (Martí, 2003: 306; Duchesne-Guillemin, 1981: 295). Similarly, their special function is embodied, which means that they construct their specific role through their corporeality. Indeed, some of the terracottas are elaborately decorated with headdresses, cloaks, necklaces, earrings or tattoos.

Moreover, not all the women are depicted in the same way; hierarchies and categories are constructed through their activities (for instance, playing music) and through their corporeality (for instance, decoration or dressing). Their capacity for singing, playing, dancing or crying defines power and gender relations which are not hierarchical but asymmetrical (Waldren 1995, 36; Robertson 1987, 225).

Moving to the sanctuaries, it is important to notice that figurines with these features are both women and men alike. Both sexes participated in rituals and performed the same activities. This is also relevant because both sexes would have experienced altered states of consciousness: anthropological studies have demonstrated that singing, playing percussion instruments, praying, or smelling incense or other substances are ways of achieving these states (Pollack-Eltz, 2004). Inside the cave of Es Culleram, for example, the number of incense-burners, oil-lamps and perfume bottles indicates that the people would have inhaled drugs. Moreover, the effects of smelling oils in caves, together with the absence of light and low visibility and the presence of echoes and other sounds would promote altered states of consciousness. The many artefacts related to burning practices have both auditory and religious consequences, since fire and smoke were means of communicating with divinities.

Sometimes these altered states of consciousness may also have been related to sexual activities. Music has very often been associated with sexual practices (Mithen, 2005: 176-191). Indeed, sexuality is not separated from religion or ritual, though Judeo-Christian sentiments sought to erase this relation (Meskell and Joyce, 2003: 116). Most of our terracottas have exaggerated representations not only of genitals, but also of other erogenous zones suchas the mouth or breasts.

However, the analysis of dance reveals an interesting gender difference. We have seen above that women are essential agents in funerary rituals, including the dances and pilgrimages performed prior to the funeral itself. But when we examine the figurines in the shrines, the situation changes. Assuming the body decoration as proof of dancing, the relation between men and women is unbalanced: most of the decorated figurines, especially at Illa Plana, are men.

So gender division appears to be a feature of ritual dances in Phoenicio-Punic culture.

To conclude, some of the terracottas we describe here show how the human body is a musical instrument in its own right. Looking at these figurines in terms of corporeality, embodiment and gesture can help us to analyse them as representations of active and sensitive individuals. As for the relation between their physical traits and musical properties, the ears are particularly well designed, indicating the importance of music and sounds in performing rituals. Furthermore, some of the figurines are touching their ears with their hands, perhaps searching for an amplification effect connected to sounds and music (Lawson et alii, 1998: 124). Taken together, these materials stress that hearing was an important element in these ritual contexts as the people sought to make contact with divinities and receive their messages – especially bearing in mind that they could not read.

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PRN:WCO30680; Register: 1965,1015.1
Purchased from Ernest Ohly in 1965 Site of excavation: Amalsh? North West Iran. Date, ca.1000BC

IS THE HEPTAGRAM IN CBS1766 A DIAL?

Richard J Dumbrill

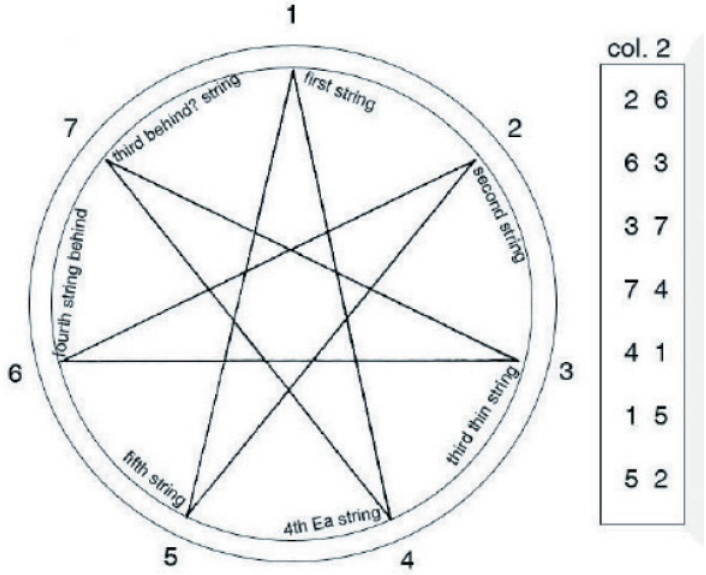
The heptagram on the tablet is inscribed within two concentric circles. The seven points of the heptagram are labelled with the names of musical strings and with numbers. This paper will argue that this was the representation of a dial showing the construction of the heptatonic scale and the location of the seven modes originating from each of its degrees.

CBS 1766

First, we must prove that the tablet is about music theory. The evidence in favour is that the terms labelling each of the points of the heptagram are the first seven musical strings, out of nine, listed in UET VII,126. There is no reason to assume that the names referred to anything else than the strings of an undefined musical instrument. The merit for this elucidation is owed to Caroline Waerzeggers and Ronny Siebes (NABU 2007-2) who gave an alternative reading, correcting Horowitz's (JANES 30) who thought that the text might be astrological.

	Horowitz	Waerzeggers	Translation
1	*da-mu*	*qú-ud-mu*	1st string of the front
2	*u$_4$-mu-sum*	*sa-mu-šum*	2nd string of the front
3	[broken]		[3rd thin string]
4	*kal/lab-ba-nu*	*é/e-a-ba-nu*	4th small string made by Ea
5	*ḫa-an-su*	*ḫa-an-su*	5th string
6	RI-x HAR-*ri*	*re-bi úḫ-ri*	4th string of behind
7	nin-x-x	*šal-šu sa? i?*	3rd string of behind

The names of the strings on their own would not be enough to construe that the text was about music theory. The construction of the star is the key to the problem. The chords of the arcs in the heptagram and the numbering of its points, from one to seven, show a typical heptatonic construction made up from the alternation of fifths and fourths. We still do this today. Another evidence to prove that the text is about music theory is that the star gives indications as to the relative pitch of its degrees.



Author's reconstruction of the hypothetical dial

This is precisely what column two emphasises. It starts by 2-6, and continues with 6-3, reading the numbers horizontally or vertically. Therefore, 2 is B, if the system is descending, or F if it is ascending. The reason for this is that in both cases the tritone appears with the last two figures: 5-2, horizontally or vertically, restricting the scale to the seven degrees of heptatonism. The numbers in the other columns make no sense and are not essential to our paper. We shall ignore them at present until the decipherment of the headers helps understand.

Why a dial?

We have to prove that the diagram represents a dial. The evidence in favour relies on two points. Firstly, could they make it, and secondly how and why would they use it.

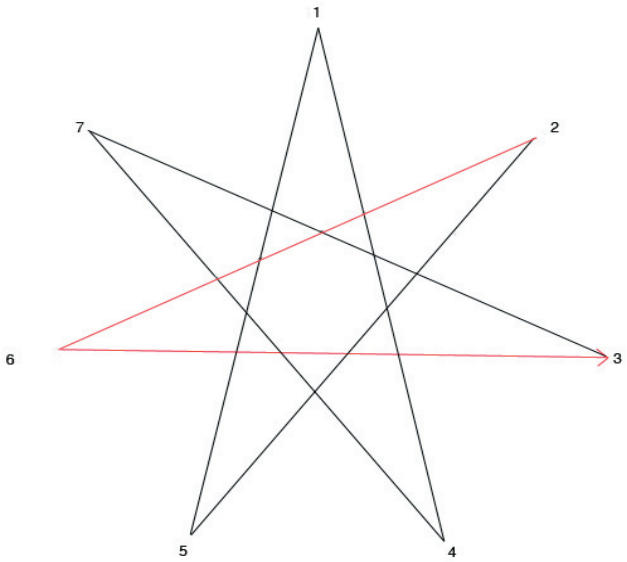
Construction of the dial

The idea that it was a dial comes from the two concentric circles. They suggest that one disk rotated onto the other. The evidence against is that there is no rivet seen to hold the disks together. A heptagram cannot be drawn with compass and ruler. The scribe drew the figure free hand. As a result, the drawing is uneven and there is no trace of a central point from which the circles were drawn. The disks could have been made of thin sheet metal, sufficiently robust, allowing for the inscription of names and numbers. But it could have been wood, velum, or whatever suitable material. Tin would be a good choice because it is reasonably malleable, sufficiently robust and easily engraved. Therefore, there was no technical hindrance for the making of the instrument in the ancient near east.

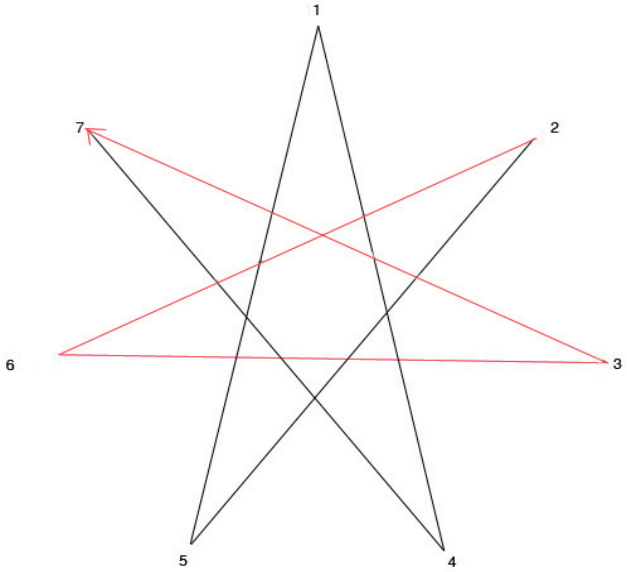
Purpose of the dial

Without purpose, there is no reason. Therefore we have to determine the function of the instrument and that its function was a technical development hitherto unknown. The chords of the arcs of the heptagram and its points define the order of the sequence of fifths and fourths necessary for the construction of the heptatonic scale. The chords represent intervals of fifths or fourths, the points are the degrees of the intervals. The seven phases of the construction are illustrated below. Note the last phase with the tritone located between 5 and 2 = F-B. However, there is no need for a dial to express the heptatonic construction.

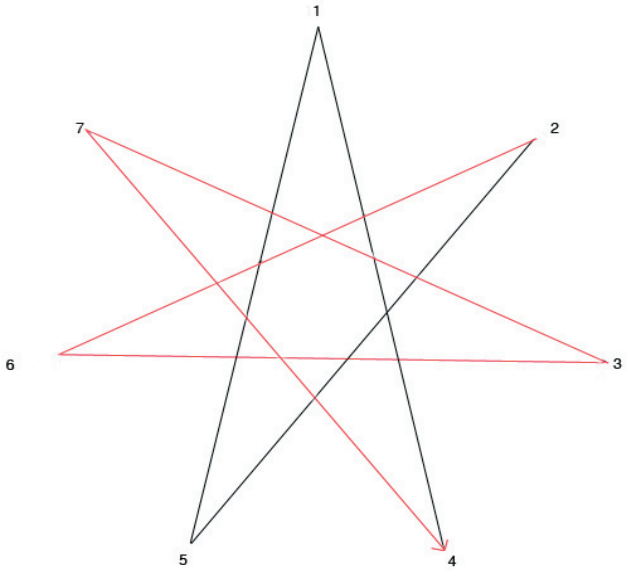
Ascending fourth 6-3 (E-A)



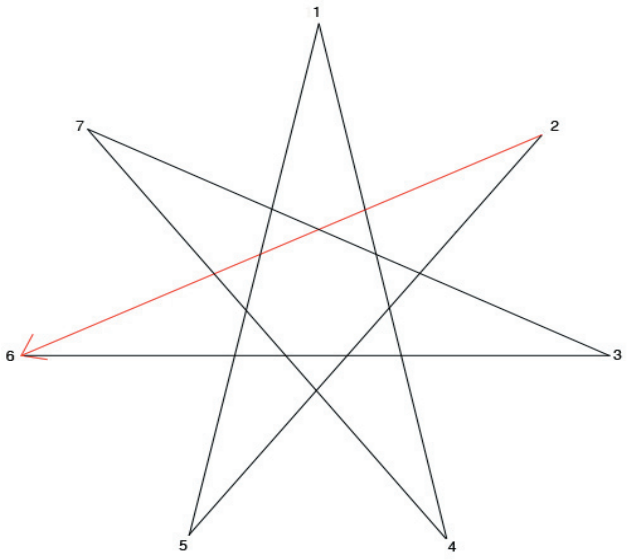
Descending fifth 3-7 (A-D)



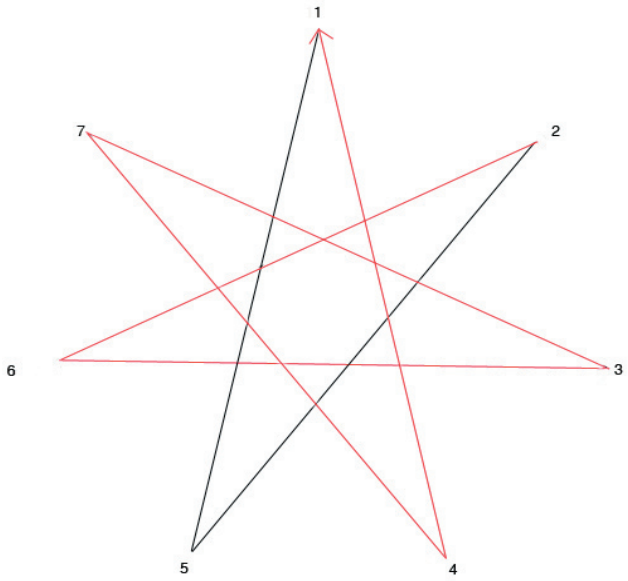
Ascending fourth 7-4 (D-G)



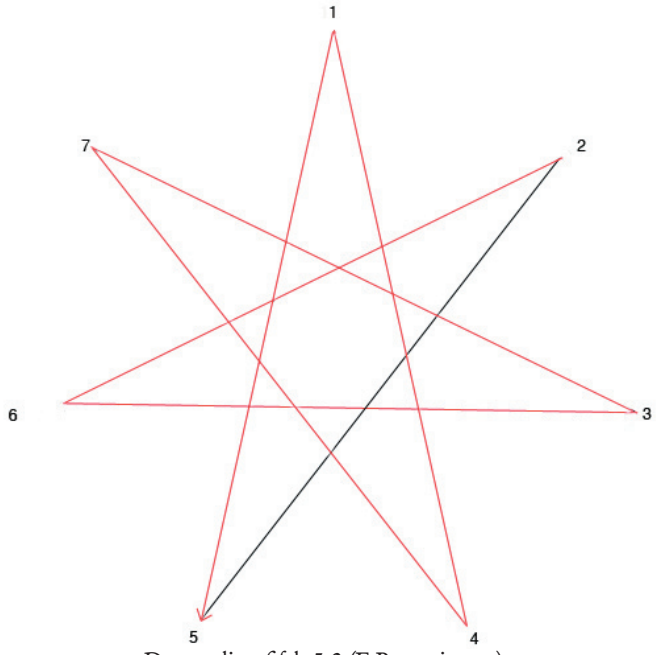
Descending fifth 2-6 (B-E)



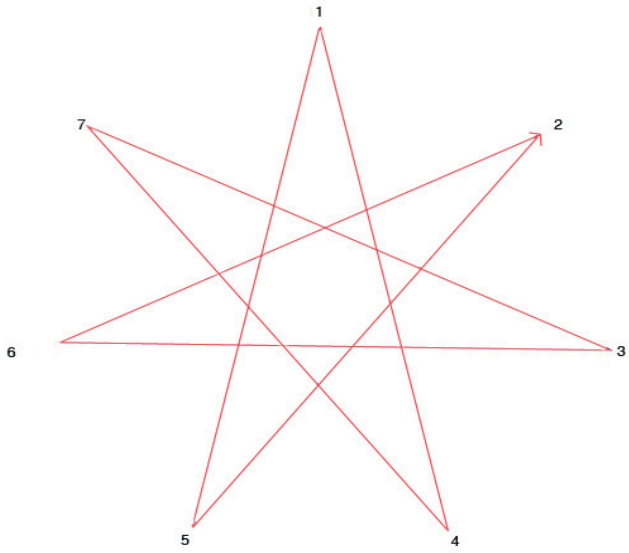
Descending fifth 4-1 (G-C)



Ascending fourth 1-5 (C-F)



Descending fifth 5-2 (F-B = tritone)



Names and numbers

Evidence in favour of the diagram being a dial finds an answer with the association of names and numbers. As it stands the dial places number 1 at 12 o'clock. It is associated with the name of the first string. This means that they could be dissociated. Number one could be aligned with string two; three; four; five; six or seven. One disk must have rotated on the other. If it did not, then they would have needed seven disks for their demonstration.

Having argued that numbers could match different names, we need to know why. On the tablet, the disks are aligned, number 1 with the name of the first string. Therefore number 2 with the name of the second string, etc. We have shown earlier that string two, aligned with number 2 would be either B should the system be descending, or F should it be ascending. Let it be descending.Then we would have a heptatonic descending scale of C=1-B=2-A=3-G=4-F=5-E=6-D=7, where, as a consequence of heptatonism, a semitone is located between numbers 1-2, and 5-6. The small disk would rotate onto the large one where semitones would be invariably placed between 1-2 and 5-6. The names of the strings would rotate onto each of the seven numbers, giving the seven modes of the heptatonic system, in the dynamic. This is a crucially important point as it diverges from the enneatonic construction in UET.VII,74, where the method is based on the correction of the tritone where the sequence ends up with eight hybrid modes, in the thetic where the method is based on the correction of the tritone where the sequence ends up with eight hybrid modes, in the thetic. Therefore it was designed for the application on an instrument. It is also a crucially important postulation that the dial was not designed for application onto an instrument. It was designed for the teaching of theory, because, exception made of the tuning of the fundamental scale, modal construction, as it is rendered, remains the prerogative of theory, not of practice. As a consequence, it is reasonable to assume that music theory was part of the syllabus.

Conclusion

I think we have satisfied our requisites. The figure must represent a dial. However, it might only have been the graphic representation of a concept which with time would have developed into the real thing. These dials can be bought today in music stores. However, their purpose has developed into harmony as they give the composition of various chords in all keys, but the principle is the same as it relies on the location of semitones. It is reasonable to assume that the Babylonians invented the device as a consequence of heptatonism.

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BM 134704
PRN:WCO25841; Register: 1965,1015.2
Purchased from Ernest Ohly in 1965. Site of excavation: Amalsh? North West Iran. Date, ca.1000BC

HARMONIC MYTHOLOGY

Nine interdisciplinary research notes

Leon Crickmore

'...there are hints in the evidence-bases of several disparate disciplines which suggest that each of the four ancient literate civilizations (South Asia, Middle East, East Asia and Europe) developed, and possibly shared systems of mathematical and music theory with extra-musical associations. If we seriously wish to pursue this developing area of research, we may need to coin some new term, such as 'Harmonic Mythology' to describe it.' (Music Theory Spectrum, Vol. 30, no.2, Fall, 2008, p. 331)

1) Tracing a Babylonian origin for the Greek tonal system
2) Music theory and practice in ancient times
3) More about Plato's 'two harmonies'
4) Hesiod's 'races' and 'political degeneration' in Plato
5) Squaring the circle
6) Plato's Republic: the 'cave' and the 'divided line'
7) The music of the spheres
8) One hundred and fifty three fishes
9) Harmonic mythology

Appendix: The Byrom Collection

I Tracing a Babylonian origin for the Greek tonal system

This research note explores whether certain innovations, traditionally attributed to the Greeks, were in fact imported from Mesopotamia. It questions whether the earliest documentation for some such items might not be better considered as the formalization of a prior oral tradition, rather than as evidence for a newly invented system or practice.

In the catalogue of the British Museum exhibition Babylon: *Myth and Reality*, Irving Finkel writes[1]

> 'Given that cuneiform writing, and the knowledge preserved in it, became totally extinct during the first few centuries AD, it is not surprising that the Western world has looked no further back for its cultural heritage than to the Greek and Latin authorities of classical Antiquity. The intellectual heritage from the classical authors was so great and so pervasive that – even after the decipherment of cuneiform in the nineteenth century – it was a long time before such acknowledgement was even considered with regard to the ancient Mesopotamian world.'

Stephanie Dalley[2] has provided a wide-ranging treatment of this issue in which she notes:

> 'In the field of music, for instance, when scribes were trained in the texts which describe the tuning of the harp or lyre, they automatically learned the system later known as Pythagorean tuning. This goes back at least into the Middle Bronze Age in Babylonia, more than a thousand years before the lifetime of Pythagoras the Greek.'

In the light of such considerations, there is a need to explore in more detail the possibility of a Babylonian origin for the diatonic[3] tonal systema of ancient Greece.

Addressing the Musical Association in the early 1930s, Wilfred Perrett[4] (1931-2) commented that

> 'The only professor of Greek I have ever known who was also a musician always refused on principle to give me any help with a stiff passage from a Greek author on music. His reply was always the same: 'Put that stuff away. Nobody has ever made head or tail of Greek Music, and nobody ever will. That way madness lies.'

In a similar vein the editor of a distinguished academic journal for Oriental Studies rejected a paper from the present author with the remark: 'we do not publish articles on music or astronomy'. Fortunately, all this is beginning to change. Despite the limited amount of actual music surviving from ancient Greece and Mesopotamia, musicologists now have a fair grasp of the music theory of both civilizations. The general reader may wish to ignore some of the references which follow. They are intended primarily for specialists in either Greek or cuneiform studies who require a quick summary of the present state of knowledge about music in the companion discipline. Perhaps the most succinct and accessible account, both for musicians and for the general reader, of the fruits of recent research into the music of ancient Greece is the article by Thomas J. Mathiesen[5] in the New Grove Dictionary of Music and Musicians. There is also his book Apollo's Lyre[6]. Whilst from Britain, on the classical side there is Martin West's Ancient Greek Music[7]. There are also the papers of the 1999 colloquium at the University of Warwick[8]. A comparable summary of the research findings about music in Mesopotamia is Anne Kilmer's article 'Mesopotamia' in the New Grove Dictionary[9]. Or from Britain, Richard Dumbrill's book The Archaeomusicology of the Ancient Near East.

From all these sources it is clear that music and music theory played a much more significant role in these ancient cultures than has so far been acknowledged. Elsewhere[11], I have attempted to summarize what we now know about this musical and mathematical tradition. There remains considerable scope for research which can provide fresh insights into the evolution of ancient Greek culture from the Babylonian.

Conclusion

Greek and cuneiform scholars need to collaborate, with a shared purpose, to explore together the elusive yet far-reaching manifestations of our Babylonian inheritance.

Notes

1 Finkel, I. L., Babylon: *Myth and Reality*, (2008), The British Museum Press: 190-1.

2 Dalley, S., (ed.) *The Legacy of Mesopotamia*, (1998), OUP : 19.

3 Greek music theory describes three classes of tetrachord: the diatonic, the chromatic and the enharmonic. For the sake of simplicity, comments in the main text are restricted to the diatonic genus. Admittedly, chromatic and enharmonic music was highly fashionable in fifth century Athens. But there is evidence suggesting that the diatonic genus existed earlier and persisted longer. It is still in use by both classical and popular musicians today. I therefore tend to view the practices of musicians composing for the fifth century Athenian theatre as a short-term deviation from a diatonic tradition, analogous, perhaps, to our more recent fashion for atonal music.

4 Perrett, W., The Heritage of Greece in Music, *Proceedings of the Musical Association*, 58 (1931-2): 85

5 Mathiesen, T. J., Greece I, *The New Grove Dictionary of Music and Musicians*, 10, (2001): 327-48.

6 Mathiesen, T. J., *Apollo's Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages*, (1999), University of Nebraska press.

7 West, M., *Ancient Greek Music*, (1992), OUP.

8 Murray, P. & Wilson, P., (Eds.) *Music and the Muses: The Culture of Mousike in the Classical Athenian City*, (2004), OUP.

9 Kilmer, A. D., Mesopotamia, *The New Grove Dictionary of Music and Musicians*, (2001), 16: 480-487.

10 Dumbrill, R. J., *The Archaeomusicology of the Near East*, (2000), Trafford.

11 Crickmore, L., A re-valuation of the ancient science of harmonics, *Psychology of Music*, 31/4: 391-403.

II Music theory and practice in ancient times

This research note offers a speculative interpretation of the significance of the animal musicians and animal orchestras found in Mesopotamian iconography. On the assumption that documentary evidence may sometimes represent the formalization of an earlier oral tradition, this note extrapolates from mediaeval evidence backwards in time.

In ancient times a hierarchical distinction was made between music theory and music practice. As part of a discussion about music theory (harmonics) in his Republic (530d-531c), Plato castigates the Pythagoreans as those who 'use their ears instead of their minds'. Aristoxenus, a pupil of Aristotle, was contemptuous of Plato's view. In his *Harmonic Elements*, he holds that the notes of the scale should be judged, not by mathematical ratios, but by the ear. This opinion has formed the basis of all subsequent scientific musical aesthetics. It remains the orthodox view today.

Nevertheless, Plato's distinction between theoretical and practical music was passed on into mediaeval thought, for instance, in the writings of Boethius (*De Institutione Musica*, I, 34):

> *'Is vero est musicus qui ratione perpensa canendi scientiam non servitio operis sed imperio speculationis adsumpsit*[1]'

A few centuries later, a verse by Guido d'Arezzo expresses the same sentiment even more stridently, in a manner which, if that age had shared our modern fashion for political correctness, would have been likely to have been censured:

> *'Musicorum et cantorum magna est distancia: Isti dicunt, illi sciunt quae componit musica. Nam qui facit quod non sapit definitur bestia*[2]'

I believe that this tradition of distinguishing philosophically between practical and theoretical arts may have originated in ancient Mesopotamia, before being exported to Greece and later Rome. If this be so, it would explain the regular appearance in Mesopotamian iconography of cartoons containing animal musicians and animal orchestras[3] which still puzzle specialist scholars in that field – see Figure 1, to the right.

Conclusion

It is recommended that scholars of Mesopotamian iconography re-examine their relevant data concerning animal musicians and its provenance in the light of the speculative possibility proposed in this note.

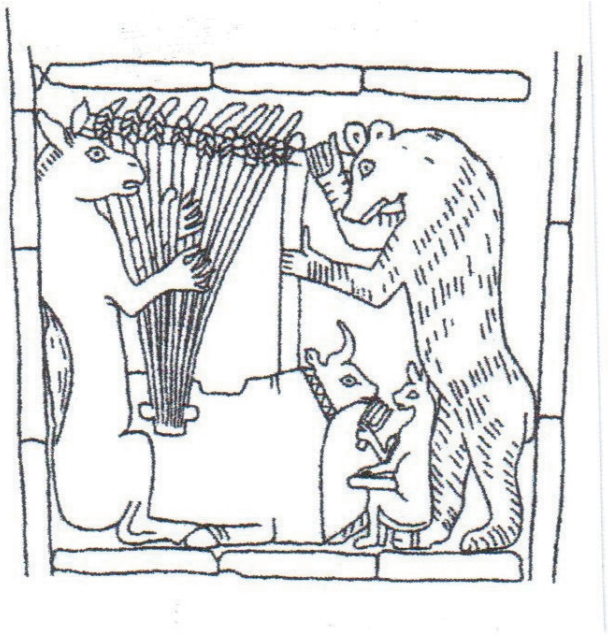


Fig.1. Shell inlay from Ur showing musicians depicted as various animals

Notes

1 'But a musician is one who has gained knowledge of making music by weighing with reason, not through the servitude of work, but through the sovereignty of contemplation'. (Bower, C. M. tr. *Fundamentals of Music: Anicius Manilius Serverinus Boethius*, Yale University Press, 1989: 51).

2 'There is a great distinction between musicians and performers. The latter sing or play, while the former understand what constitutes music. And someone who does something without understanding its nature, is by definition a beast' – free translation by the author.

3 Dalley, S., *The Legacy of Mesopotamia*, OUP, (1998): 19.

III More about Plato's 'two harmonies'

Research notes 3 & 4 are, in effect, appendices to the author's article 'The musicality of Plato' (see footnote 2). Research Note 3 speculates about a nine fold extension of Plato's 'two harmonies' which might possibly be traced back to a cuneiform text.

In a notoriously difficult passage from Plato's *Republic*, (545c-546d), the Muses speak of 'two harmonies'. Classical scholars are generally agreed that the three numbers required to solve the enigmatic arithmetical description of these harmonies contained in the sentences that follow, are: 2700, 3600, and 4800. But as Waterfield[1] notes in his translation: 'Scholars nowadays largely ignore the passage'. Disappointed by such a cursory treatment of the problem, the present author has published a commentary on the passage, viewing it from a musicological perspective.[2]

In the light of more recent evidence about the Babylonian tonal systema[3], - in particular that which can be derived from a musicological interpretation of the cuneiform tablet CBS 1766 – I believe that Plato's meaning can now be specified even more precisely.

The two harmonies are two musical scales: the only two modes which Plato admits into his ideal cities – namely the Dorian and the Phrygian octave species (*Republic*, 398c-399c).

We now know that the ancient Greek Phrygian octave species is none other than the Babylonian heptachord *embūbum*, extended by one tone to complete the octave. If, as seems highly plausible, the priest-musicians of the ancient temples of Mesopotamia quantified their heptachords, using sexagesimal proportional arithmetic and numbers from their standard tables of 'regular'[4] numbers with their reciprocals, then the Phrygian scale could be defined by integers as small as: 27, 30, 32, 36, 40, 45, 48, (54). For Plato, however, the Dorian octave species was the more important of the two. It was the scale through which a genuinely musical man could render his whole life harmonious in a truly Dorian mode, 'the only harmony that is genuinely Greek' *(Laches,* 188d).

If we try to quantify the Dorian mode in the range of 27-48 (or 54), we find that it cannot be done entirely in integers, as the custom demanded. I believe that it was for this reason that Plato multiplied each of the Babylonian tone-numbers by one hundred, to produce: 2700, 2880, 3240, 3600, 4050, 4320, 4800, and 5400[5].

Of course, to be genuinely 'Greek' the Dorian mode would have had to be in Pythagorean tuning rather than the just tuning expressed above: 9:8, 9:8, 256:243, 9:8, 9:8, 9:8, 256:243. To do so would require some alternative initial tone-number, such as 384. Nevertheless, the passage in the Republic does suggest that, contrary to the conventional assumption of musicologists, Plato was familiar with the arithmetic of just tuning. Plato displays the tone-numbers required to define both the Dorian and the Phrygian octave species in Pythagorean tuning, through the first nine terms of his 'World Soul' in the *Timaeus*[6], (*Cf.,* Appendix III).

The ancient Greeks would have described heptachordal scales as comprising two conjunct tetrachords –that is, two sets of four strings, the last of the first group also serving as the first of the second group. In tone-numbers, the 'fixed' tones of such scales can be expressed: 2700 : 3600 :: 3600 : 4800. Plato restricts his comments to these four numbers. For their own octave species the two tetrachords had to be disjunct – that is, there was a gap of a tone (9:8) between the fourth string of the first tetrachord and the first of the second tetrachord. Comparable tone-numbers, including the gap, would be: 2700 : 3600 :: 4050 : 5400.

If the word 'harmony' is taken to refer to a musical scale, the gaps can be filled as either a Dorian or a Phrygian mode.

In the notorious extract from the *Republic*, the Muses speak cryptically of the first harmony being a 'square'. 3600^2 = 12,960,000 (60^4), Plato's 'sovereign geometrical number'. They describe the second harmony as an 'oblong'. The product of the two outer tone-numbers (2700 x 4800) is also equal to Plato's 'sovereign geometrical number' (60^4). Modern mathematicians would describe 3600 in this context as the geometric mean between 2700 and 4800. In the *Timaeus* (32b), Plato refers to the geometric mean as the 'fairest of bonds'.

I strongly suspect that Plato may have conceived of the nine Muses, whom, in this passage, he has chosen to speak on his behalf, as hypostasized factors of his 'sovereign geometrical number' (60^4). This idea is explored in detail in Appendix I, using the names of the Muses provided by Hesiod (*Theogony*, 77-9). The three basic numbers of the 'two harmonies' are all present (2700 : 3600 : 4800). 3600, the number of Terpsichore, Muse of chorus and dancing, serves as the geometric mean not only between 2700, Euterpe, Muse of music, and 4800, Urania, Muse of astronomy – the 'two sister sciences' (*Republic*, 530d) - but also between the other three palindromic pairs: (1-9, 3-7 and 4-6). The evidence for adopting a palindromic approach lies in the cuneiform tablet UET VII, 126, which numbers the strings of a nine-stringed instrument – perhaps a sammu – as follows: 1, 2, 3, 4, 5, 4, 3, 2, 1, adding the appropriate Babylonian string-names. Appendix II displays these, together with the comparable Greek nomenclature. Both appendices include hypothetical tone-numbers, ratios and modern pitches by letter-name. The ratios between the tone-numbers are strictly palindromic with regard to the placing of the tones and semi-tones, although to preserve integers the major and minor tones (9:8 and 10:9) have sometimes been exchanged. The underlined numbers indicate tone-numbers which have been increased by a syntonic comma (81/80) for Pythagorean tuning. If these speculations have any truth in them, then, contrary to the currently received opinion, the arithmetic of just tuning, as used in Babylonian times, must have been familiar to Plato and to his audience.

Finally, appendix III shows the Dorian and Phrygian octave species in Pythagorean tuning, with tone-numbers which correspond to the first nine terms of the scale which Plato describes as the 'World Soul' *(Timaeus, 34-37).*

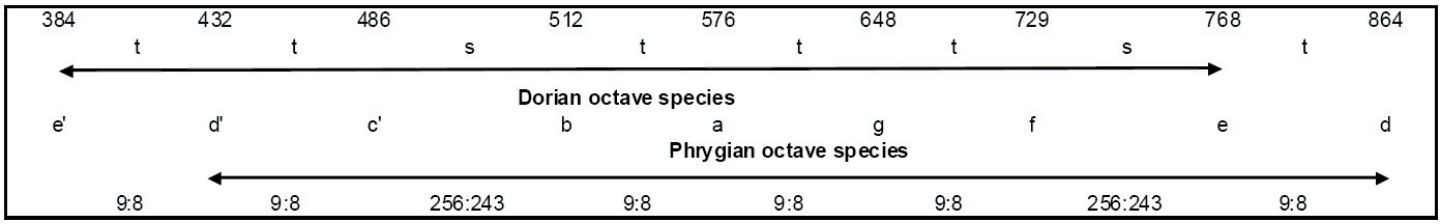
APPENDICES

2400		2700		3000		3200		3600		4050		4320		4800		5400
	t		t		s		t		t		s		t		t	
	9:8		10;9		16:15		9:8		9:8		16:15		10:9		9:8	
a'		g'		f'		e'		d'		c'		b		a		g
Clio		Euterpe		Thaleia		Melpomene		Terpsichore		Erato		Polyhymnia		Urania		Calliope

Appendix I: the Muses as factors of 60^4 (3600^2)

Name of string	Front		Next		Third		4th small		5th		4th		3rd		2nd		Behind	
					thin						behind		behind		behind			
String numbers	1		2		3		4		5		4		3		2		1	
Hypothetical pitches	a'		g'		f'		e'		d'		c'		b		a		g	
Tone numbers	36		40		45		48		54		60		64		72		80	
Ratios		10:9		9:8		16:15		9:8		10:9		16:15		9:8		10:9		
Intervals		t		t		s		t		t		s		t		t		
Greek system	576		648		729		768		864		972		1024		1152		1296	
(x 16)		9:8		9:8		256:243		9:8		9:8		256:243		9:8		9:8		
Greek string name	Nete		Para-nete		Trite		Nete		Para-nete		Trite		Paramese		MESE		Lichanos	
Tetrachords		Hyperbolaion						Diezeugmenon						Disjunction			Meson	
														(diazeuxis)				

Appendix II: UET VII 126 and Greek equivalents:Tone numbers define the Babylonian heptachord *pītum* in Just tuning with tone-numbers taken from the standard tables. The corresponding tone-numbers in the Greek system define the hypodorian octave species in Pythagorean tuning. The underlined numbers differ by a syntonic comma (x 81/80).


384 432 486 512 576 648 729 768 864
t t s t t t s t
Dorian octave species
e' d' c' b a g f e d
Phrygian octave species
9:8 9:8 256:243 9:8 9:8 9:8 256:243 9:8

Appendix III: The Dorian and Phrygian octave species in Pythagorean tuning, with tone-numbers corresponding to the first nine terms of Plato's 'World Soul' (*Timaeus*, 34-7). The original terms, 1, 2, 3, 4, 8, 9, 27 have to be multiplied by 6 and then by 64 to ensure integers.

Conclusion

Plato's musical mathematics belongs to a Mesopotamian tradition. Whether or not Plato was aware of this remains an open question.

Notes

1 Waterfield, R., Plato Republic,Translated with an Introduction and Notes, OUP,1993, p.434

2 Crickmore, L., The musicality of Plato, *Hermathena*, No. 180, 2006.

3 Crickmore, L., Research Note; A Musical and Mathematical Context for CBS 1766, *Music Theory Spectrum*, 30/2, 2008

4 The term 'regular' numbers refers to integers in the form $2^p3^q5^r$, that is numbers generated by multiples or powers of 2, 3 and 5.

5 Crickmore, L., The musicality of Plato, *Hermathena*, 180, 2006, p.37, Figure 10, and p.34.

6 Crickmore, L., A re-valuation of the ancient science of harmonics, *Psychology of Music*, 31/4, p.396.

IV Hesiod's 'races' and 'political degeneration' in Plato

Research note 4 continues the interpretation of Plato's text in the light of the ancient science of harmonics. An apparent link with Hindu mythology is uncovered.

It is surprising how in their translations classical scholars tend to shy away from elucidating Plato's cryptic descriptions of musical and mathematical concepts such as the 'two harmonies' in the *Republic* (545d – 547a)[1]

For my part, viewing such passages from a musicological perspective[2] has led me to two main conclusions:

(1) Plato's 'two harmonies' are musical scales: namely, the Dorian and Phrygian octave species, the only two modes which Plato is prepared to admit into his ideal cities (*Republic*, 398c – 399c). To demonstrate this assertion, the two scales have to be defined in ratios, by tone-numbers in a form which modern musicians would call just tuning: (Table I below)

Plato's range 2700-4800 corresponds to the Babylonian heptachord *išartum* (rising) or *nīd qablim*, (falling). (Table II below)

The range 2700-4800 corresponds to the Babylonian heptachord *embūbum*. Tone-numbers taken from the standard Babylonian tables of 'regular' numbers and their reciprocals have been multiplied by 1003 (27, 30, 32, 36, 40, 45, 48).

The same two scales also feature in the more traditional Pythagorean tuning as the first nine terms of Plato's 'World Soul' *(Timaeus,* 34-37): (Table III below)

It seems likely that Plato's main audience at the Athenian Academy would have been familiar with both the Pythagorean and the just aspects of the harmonic tradition.

(2) Plato uses the Muses to voice a theory of political degeneration through analogy with faulty musical tuning. In Research Note 3, I postulated that Plato may have conceived the Muses as hypostatized factors of his 'sovereign geometrical number' (60^4)[4]

Towards the close of his book *Beyond Measure: A Guided Tour through Nature, Myth and Number,*[5] Kappraff writes:

> 'Ancient civilizations appear to have been aware that the solar and lunar cycles were incommensurate and that this found an echo in the problem of creating a musical scale that required a finite number of tones.'

This irresolvable fault in the musical system is different in Pythagorean and in just tuning. In the former, it is known as the 'Pythagorean comma' – the discrepancy between six tones $(9/8)^6$ and an octave (2:1) –that is, 524288: 531441^6.

In the latter, it is known by the modern acoustical term *diesis* – the discrepancy between three pure thirds $(5/4)^3$ and an octave (2:1) – that is, 125:128.

Finally, Plato's Muses conclude their explanation of the origins of 'faction' with a difficult passage on which I have so far never commented[7]:

> '...guardians first begin to neglect us by having less consideration than is required, first, for music, and, second, for gymnastic; and from there your young will become more unmusical. And rulers chosen from them won't be guardians very apt at testing *Hesiod's races and yours – gold, and silver and bronze and iron...'*

Hesiod[8] describes the gradual deterioration of the human race from its 'golden age' to the present age of 'iron'. However, whereas Plato names only four ages and their races (gold, silver, bronze and iron), Hesiod proposes a fifth: the age of the 'demi-gods' which occurs between the bronze and iron ages. The age of the 'demi-gods' – that is, of the heroes of epics, born from unions between gods and mortal women – constitutes an unexpected temporary reversal of direction in the cycle of degeneration, an improvement, in fact.

Hindu mythology contains a similar story expressed in terms of *yugas* or cosmic cycles[9]. The *mahayuga* of 4,320,000 human years is divided into four successive *yugas*:

> (1) *kritayuga.* A golden age which lasted 4800 divine years or 1,728,000 human years (*i.e.*, x 360);
> (2) *tretayuga*. An age when mankind lived lives which were three-equarters virtue and one quarter vice. This age – presumably corresponding to the Muses's 'silver' age - lasted 3600 divine years or 1,296,000 human years;
> (3) *dvaparayuga*. In this age, presumably equivalent to the Muses's age of 'copper', men were half good and half evil. This *yuga* lasted 2400 divine or 864,000 human years;
> (4)*kaliyuga*. The present age of 'iron', when true virtue has almost disappeared. Conflicts are manifest. Living things only live for a quarter of their potential existence. This age will end with destruction by fire and water, after 1200 divine years or 432,000 human years.

I have underlined the three Platonic numbers in this

system: 4800, 3600 and 1,296,000 (1/10 of Plato's 'sovereign geometrical number'). The absence of 2700 is interesting. Could this correspond to Hesiod's age of the 'demi-gods'?

The ratios between the four *yuga* numbers are: 3:4, 2:3, and 1:2 (the degenerating reciprocals of 1, 2, 3, 4, the Pythagorean *tetractys*, and the cosmological numbers which Plato uses to make an intellectual joke in the opening words of his *Timaeus*: 'One, two, three, - but where, my dear Timaeus, is the fourth of our guests of yesterday....?') 1, 2, 3, 4, are also the opening terms of our modern harmonic series, the foundation of the science of acoustics. I believe that these considerations provide a convincing example of the currently evolving branch of interdisciplinary study for which Graham Fearnhead has coined the term 'harmonic mythology.'[10] They hint at the possibility of the existence in ancient times of a musical/mythological/mathematical and cosmological oral tradition across the four literate civilizations of South Asia, the Middle East, East Asia and Europe.

Conclusion

There is a consistency in the use of certain 'regular' numbers derived from Mesopotamian music theory in both Greek and Hindu mythology.

Notes

1 *e.g.,* Cornford (1945) omits 'the extremely obscure description' of Socrates' 'sovereign number'. Waterfield (1993) notes 'scholars nowadays largely ignore the passage'.

2 *e.g.,* Crickmore, L., The musicality of Plato, *Hermathena,* 180, (2006): 19-41, and Research Note 3.

3 *Op. cit.,* in note 2: Figure 10 and p.34. Also Research Note 3

4 For convenience, I reproduce Appendix 1 of that note below, as table IV.

5 Kappraff, J., Beyond Measure: A *Guided Tour Through Nature, Myth, and Number,* (2002), World Scientific: 561

6 Given the Babylonian canonical year of 360 days, with 30 days to each month, the annual cycle can be expressed as a musical scale with tone-numbers in the range 360-720. 360 multiplied by the Pythagorean comma or its reciprocal, respectively, produces 364.91 days for the solar year and 355.15 for the lunar year – reasonable approximations to our modern scientific equivalents: 365.242199 and 354.3672. Both Plato's 'two harmonies' can be defined in the range 360-720. Dorian: 360, 400, 450, 480, 540, 600, 675, 720. Phrygian: 360, 405, 432, 486, 540, 600, 640, 720.

7 Bloom, A., (tr.) *The Republic of Plato*, (1991), Basic Books: 224

8 West, M. L., Hesiod: *Theogony: Works and Days*, (1981), OUP: 40-42.

9 Ifrah, G., (tr. Bellos, D.; Harding, E, F.; Wood, S.; Monk, I.) The Universal History of Numbers from prehistory to the invention of the computer, (1998), Harvill Press: 506-7.

10 See Crickmore, L., (2008) The Tonal Systems of Mesopotamia and Ancient Greece: Some Similarities and Differences *ARANE* : 13-14, http://www.iconea.org/arane.htm

Table I

2700		2880		3240		3600		4050		4320		4800		5400
e		f		g		a		b		c'		d'		e'
	16:15		9:8		10:9		9:8		16:15		10:9		9:8	

Dorian octave species (rising) in just tuning

Table II

2700		3000		3200		3600		4000		4500		4800		5400
d		e		f		g		a		b		c'		d'
d'		c'		b		a		g		f		e		d
	10:9		16:15		9:8		10:9		9:8		16:15		9:8	

Phrygian octave species (rising and falling) in just tuning.

Table III

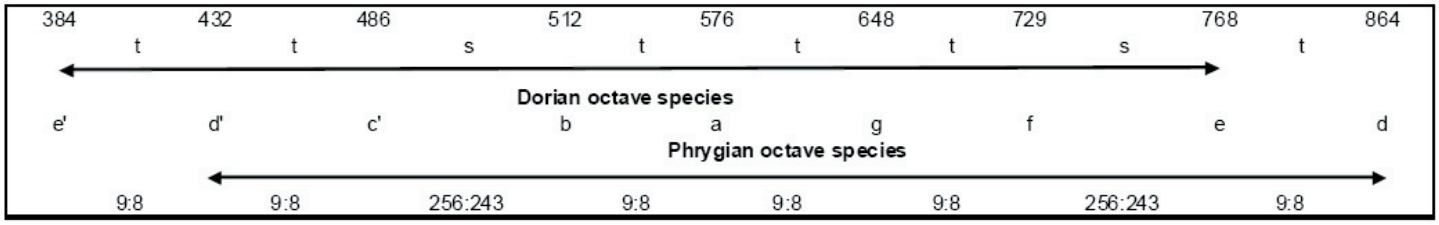

384 432 486 512 576 648 729 768 864
t t s t t t s t
Dorian octave species
e' d' c' b a g f e d
Phrygian octave species
9:8 9:8 256:243 9:8 9:8 9:8 256:243 9:8

Table IV

2400		2700		3000		3200		3600		4050		4320		4800		5400
	t		t		s		t		t		s		t		t	
	9:8		10:9		16:15		9:8		9:8		16:15		10:9		9:8	
a'		g'		f'		e'		d'		c'		b		a		g
Clio		Euterpe		Thaleia		Melpomene		Terpsichore		Erato		Polyhymnia		Urania		Calliope

The Muses as factors of 60^4 (3600^2)

V Squaring the circle

In memory of John Michell (1933-2009)

Research note 5 and also research notes 6 and 8, are not, strictly speaking, concerned with the arithmetic of 'harmonic mythology'. Their mathematical content belongs to certain features of ancient geometry which were proportioned to 'regular' musical numbers when used in architectural design.

The Pythagoreans distinguished four branches of number-study[1]

Arithmetic – number in itself;
Geometry – number in space;
Music or Harmonics – number in time;
Astronomy – number in space and time.

During the Middle Ages these four areas of mathematical study formed the *quadrivium* of higher education, which complemented the *trivium* of grammar, logic and rhetoric.

So far, the research notes have dealt with the first and third of these categories only. Consideration must now be given to the role of geometry and astronomy in 'harmonic mythology'. One benefit of geometry for the ancient Greeks was the way it allowed their mathematicians to work with irrational numbers as well as integers. For instance, according to the theorem of Pythagoras, the diagonal of a square of which the side is one unit in length is 2. Theon[2], a mathematician of the second century AD, formulated the following integer approximations for 2: 7/5 and 17/12. Thus the diagonal of a square with a side of 30 units could be considered to be 30 x 7/5 = 42 units in length. Similarly, if the side of the square were 36 units, the diagonal would be 36 x 17/12 = 51 units. By using these constants to calculate an integer value for appropriate irrational lengths, their values could be proportioned to numbers from musical harmonics for the purposes of architectural design.

Research notes 5 and 6 are concerned with two classical problems of ancient geometry: 'squaring the circle' and 'the divided line', and their application in religious thought and in Plato's theory of knowledge, respectively.

Research note 7 will then look at the 'harmonic mythology' underlying the concept of 'the music of the spheres'.

The problem of 'squaring the circle' was the quest to find a method for the construction of a square with the same area or circumference as a given circle. The problem dates from the time of Anaxagoras in the fifth century BC, and it was not until 1882 that Lindemann demonstrated the impossibility of such a construction by demonstrating that π is a transcendental number – that is, one that cannot be expressed as the root of a polynomial equation with integer co-efficients.

The idea of squaring a circle was important to the ancients because for them the circle symbolized the celestial sphere, and the square the earth. The construction of a 'squared circle' could therefore be conceived as a sign of the unity of heaven and earth. Ton Brunes's star[3] illustrates one way in which ancient geometers may have attempted to solve their problem using only compass and straight edge. Its level of error is about 1.8%.

Michell[4] has suggested a numerical archetype in integers for the dimensions of a circle of which the circumference is approximately equal to the perimeter of a square: diameter of circle: 14 units; side of square: 11 units; perimeter of square and circumference of circle: 44 units (assuming that π = 22/7).

These three integers (14, 11, and 44) can, of course, be proportionately increased. Multiplied by 720[5] they become 10080, 7920 and 31680, respectively. Michell argues that these were the dimensions of the 'squared circle' of the New Jerusalem (Apocalypse, 21: 16-17). However, a degree of caution is called for at this point, for when Michell applies this archetypal pattern to various ancient sites, one is sometimes reminded of the story of Procrustes who cut his captives legs to fit his bed. Nevertheless, 7920 miles – the side of the square - is approximately the mean diameter of the earth (Michell cites the actual diameter according to the *Encyclopaedia Britannica* as 4917.4 miles). In what Michell (pp104-5) describes as 'the canonical dimensions of the earth' the diameter of the sun is 864,000 miles (not too bad an estimate for 864950?). In Hindu mythology 8640 million years is known as 'one day and one night of Brahma'. Our own 24-hour day has 86400 seconds, a remnant of this kind of ancient thinking. With regards to music, the number 864 is the tone-number for the lowest pitch in the *Phrygian* octave species in Pythagorean tuning[6]. It can also be used to define the Babylonian heptachord *embūbum* similarly. In such a manner, by according qualitative as well as quantitative attributes to numbers, at various times and in various places the Pythagoreans were able to unify music, science and mythology.

Conclusion

It would be an over-simplification to dismiss ancient attempts to 'square the circle' as naïve. While acknowledging its impossibility, we must also recognise its profound significance within a discarded world-view.

Notes

1 Guthrie, K. S., (Ed. Fideler, D. R.), *The Pythagorean Sourcebook and Library*, Phanes Press, 1987: 34

2 Theon of Smyrna, *The Mathematics Useful for Understanding Plato*, - trs. from Greek/French edn. of J. Dupuis by R. & D. Lawlor – (1979) Wizard's Bookshelf, San Diego (Cal.)

3 Brunes, T., *The Secrets of Ancient Geometry – And its Use*, **I,** (1967), Copenhagen: Rhodos. See also Kappraff, J. *Beyond Measure: A Guided Tour Through Nature, Myth, and Number*, (2002), World Scientific: 172-4.

4 Michell, J., *The Dimensions of Paradise*, (1988), Harper & Row: 69.

5 In ancient Mesopotamia, the musical octave defined by the tone-numbers 360-720 had cosmological significance. See Research Note 4, p.2, footnote 6.

6 See Research Note 3, Appendix III.

VI Plato's *Republic*: the 'cave' and the 'divided line'

Research Note 6 continues to explore Plato's symbolic mathematics by tracing an analogy between a problem of ancient geometry and Plato's philosophical concepts.

It is somewhat paradoxical that in his *Republic*, Plato, while advocating rigorous dialectical thinking, relies so heavily on myths and analogies such as the 'cave' (514a-517a) and the 'divided line' (509d-511e)[1].

The 'cave' represents education and the lack of it. The uneducated are seen as prisoners in a cave, where they take for reality the shadow-play of puppet-like figures cast by a fire behind them. In modern terms, they sit, as it were, before a computer monitor, constructing lives of virtual reality. Anyone who ever manages to escape from the cave and witness true reality in the light of the sun, receives a harsh reception, if on return to the cave he tries (like Socrates) to pass on the fruits of his enlightenment.

The 'divided line' is an altogether more complicated simile, relating different kinds of knowledge to their respective objects and proportionality to each other. Classical scholars continue to debate various problems associated with these alignments. But to attempt to simplify: the line is first divided, unequally, between things 'seen' (*to horaton*) and things 'intellected' (*to noēton*). Next, things 'seen' are subdivided in the same proportions as the division of the original line, presumably between the kind of images seen in the cave and those of living things, seen when reality is experienced by sunlight. Things 'intellected' are then similarly subdivided in the same proportions, to distinguish those derived from a hypothesis and mathematical or discursive reasoning, from those which are grasped by direct intuition.

These two segments taken together constitute 'dialectic'. Adam[2] sees in all this an affirmation of mathematics as a basis for understanding the 'golden chain' between Divine Ideas and particulars, on which the *Timaeus* is a commentary.

I believe it to be reasonable, therefore, to interpret the analogy of the 'divided line' strictly mathematically, drawing on what has subsequently become known as the 'golden ratio'[3]

Euclid describes such an unequal division of a line as 'the extreme and mean ratio'. He defines it in relation to areas in Book II of his *Elements*, and to proportions in Book VII. Moreover, in Book IV Euclid uses the extreme and mean ratio in presenting a method for the construction of a pentagon – the sacred symbol of the Pythagoreans, in which, if overlapping chords are drawn between its five points, each chord exemplifies a 'divided line'.

The mathematical problem underlying all this is how to divide a line so that the shorter segment is to the longer, as the longer is to the whole line. Thus if a line AB is so divided at point C, then CB: AC :: AC : AB (*i.e.,* AC + CB):

Alternatively, if we consider the two segments of the line as sides of a rectangle, and assume that the shorter side (CB) = 1 unit, modern mathematicians would call AC by the Greek letter *Tau (T)* for *tomē*, (a cut); while art historians would use *Phi* (*Φ*), after Phidias, the ancient Greek sculptor. It can be demonstrated algebraically that the value of *T* and *Φ* is root 5 plus one, divided by 2. This works out at approximately 1.618. I say 'approximately' because *T* and *Φ* are irrational numbers.[4] They cannot be written as integers, or as the quotient of two integers. Stewart[5] describes *Phi* as 'the most irrational number.....the worst of them all'. Curiously, the reciprocal of 1.618 is 0.618 (*i.e.,* 1.618 – 1). This is the value of the longer segment of a divided line one unit in length. The length of the shorter section would be $1/\Phi^2$, Plato's interest in the 'divided line' seems to have been in using it as an analogy for the ratios and proportionality between various activities of the human mind, rather than in its quantification. Bremer[6] has provided a helpfully detailed diagram of Plato's application of the extreme and mean ratio to his epistemology in the *Republic*.

Legend has it that some hundred and twenty-five years before Plato composed the *Republic*, Hippasus, a Pythagorean, worked out that the square root of two must be an irrational number. He also recognised the serious implications of his discovery. The measurements of the sacred pentagon of the Pythagoreans could not be defined in integers. The Pythagorean world-view, dependent on the philosophy that 'all is number' – that is, expressible as integers – was about to crumble. To protect itself and its beliefs, the Pythagorean community arranged for Hippasus to be drowned at sea. One is left wondering how many other geniuses who during the course of subsequent history have felt obliged to challenge religious, political and academic orthodoxies have met with a similar fate.....

Conclusion

The application of specific Euclidian elements to Plato's philosophical text offers a reasonable resolution to several interpretative disputes among classical scholars about the meaning of the proportional conditions of Plato's 'divided line'.

Notes

1 Partenie, C., (Ed.). *Plato: Selected Myths*, (2004), OUP : 51-2

2 Adam, J., *The Republic of Plato, Vol. II*, (1902), CUP : 156-163

3 Livio, M., *The Golden Ratio: the Story of Phi, the Extraordinary Number of Nature, Art and Beauty* (2002), Review. See also Faller, M. *'Suggestions for a New Divided Line'*, Pacific APA, March, 1998.

4 A possible approximation to Φ and T as an integer ratio would be 8:5 (1.6). Musically. This ratio defines a minor 6th in Just tuning. It is also a component of our modern major chords. In Pythagorean tuning 81/125 would be required. Livio, M. The *Golden Ratio*, (2002), Review: 44-5 cites cuneiform evidence that the Babylonians estimated the area of a pentagon as 1.666... but concludes that there is no mathematical evidence that the Babylonians knew about the Golden Ratio.

5 Stewart, I., *Nature's Numbers*, (1998) Phoenix: 162

6 Bremer, J., *Plato and the Foundation of the Academy*, (2002), University Press of America: 62, Figure 4

VII The music of the spheres

Research note 7 takes a birds'-eye view of the 'music of the spheres'. In modern times the 'music of the spheres' is remembered only as a poetic image. But originally it was both a scientific and a musical concept.

No note on 'the music of the spheres' can afford to exclude a reference to Jamie James's splendid book on the subject.[1] Writing as a journalist of both music and science, he explains in the Preface that his book attempts to cover:

> '....the area of over-lap between music and science, beginning at the beginning of Western civilization, when the two were identified so profoundly that anyone who suggested that there was any essential difference between them would have been considered an ignoramus, and arriving at the present day, when someone proposing that they have anything in common runs the risk of being labelled a philistine by one group and a dilettante by the other – and, most damning of all, a popularizer by both'.

It seems likely that one of the earliest discoveries of ancient empirical science would have been the invariance of the musical octave of ratio 2:1. Whatever the length of a musical pipe, half it, and its pitch rises an octave; double it, and the pitch falls an octave. This discovery led to the development of the ancient science of harmonics[2]: a numerical science, based on the ratios of pipe (and later string) length. At some stage these ratios were projected onto the heavens, hypothesizing 'the music of the spheres'. According to Adam[3], Plato's 'Sirens' (*Republic*, 617b) are 'a poetic fiction to express the music of the spheres'. He continues:

> 'The seven planets by their movements were supposed by the Pythagoreans to give forth sounds corresponding to the notes of the heptachord. This was probably the original form of the 'music of the spheres'. Later it was held that the circle of the fixed stars had a note of its own, and a 'harmony' or mode resulted like that of the octachord[4]".

Analogies were also made between such ratios and the various activities of the human psyche. Thus a rich tradition was born – musical, cosmological, philosophical – which persisted in Western thought until the seventeenth century, when the heavens began to be 'untuned' by the rise of modern science.

One contemporary musicologist who has shown willingness to treat such 'speculative music' seriously is Joscelyn Godwin[5] Part III of his book *Harmonies of Heaven and Earth* is devoted to a scholarly study of 'the music of the spheres'.

Introducing his theme (p.125), Godwin highlights the kind of mental approach required by anyone exploring this field:

> 'a readiness to shift attitudes and to keep one's mind open to several different and sometimes contradictory levels of being[6]',

adding that

> 'without that readiness, any study of planet-tone or zodiac-tone theories is limited to an academic approach which regards its subject as historically instructive but devoid of intrinsic truth'.

Godwin goes on to distinguish theories which consider the planets to be spaced in the manner of the frets on a lute, for instance, from those in which the analogy is related to speed or frequency of vibration. He also illustrates (pp143-8) how Kepler's astronomical data for the music of the spheres is about 78% accurate.

The ratios which Kepler gives for the extreme angular velocities of each planet require only two corrections to accord with modern measurements. Moreover, the planets subsequently discovered exhibit ratios of the same kind. Godwin concludes that Kepler's planetary harmonies are no less valid today than they were in his time.

Unlike most other contributors to the Pythagorean tradition in music, Kepler[7] based his work on the ratios of just tuning[8], with their pure thirds. Elsewhere[9], I have argued that 'just tuning' was likely to have been known and used in ancient Mesopotamia, as it was likewise known to Plato[10]

To help the reader to grasp the extent of the mental re-orientation which was brought about by the 'untuning' of the skies, I list below a number of pertinent considerations:

- Frequency of vibration can now be measured accurately;
- The modern scientific model for musical tuning is 'equal temperament': a system which places twelve equal semitones within the octave so that they form a logarithmic spiral;
- The fulcrum of ancient proportional arithmetic was unity (the monad). In an upward direction, an arithmetic series moved away from it (1, 2, 3 ....); in a downward direction, a harmonic series (1/2, 1/3, ¼ ....). In modern mathematics, on the other hand, the fulcrum has become zero, with negative numbers replacing the harmonic fractions;

- Zero now tends to dominate the mathematics of cosmology: for example, the density of a black hole and the big bang are both divisions by zero[11];
- Moreover, the 'two cultures' of science and arts, categorized by C. P. Snow in 1959, continue to drift perceptibly further apart.

By qualification and experience, Jamie James's expertise straddles both of Snow's 'two cultures'. This is evident from the closing statement of the Preface to his book:

> 'The key to the universe is no longer of use to anyone, because the exquisite edifice it once unlocked has crumbled into nothingness. Nonetheless, it does seem worth knowing that down through the vastest majority of history, our ancestors believed that the world made sense, that it was a place where they belonged. And because they were human even when they were wrong, we can belong there, too.'

But by the time he reaches the final chapter, he has become significantly more pessimistic. His concluding statement seems to have been dictated more by the fashions of current scientific orthodoxy than by artistic insight:

> 'Yet now that science permits us actually to hear the soundtrack of the universe in the form of random blips and howls picked up by radio telescopes, how we long for silence.'

I am unqualified in science. But I am aware from its history that over the centuries there have been a number of differing scientific paradigms: those, for example, of Ptolemy, Copernicus and Einstein. There is room for hope, therefore, that the future may bring a fresh scientific paradigm, rather less reductionist than the present one. Meanwhile, I can choose to close this Research Note with a quotation from Elizabeth Jenning's poem *'A Sought Music'*[12]:

> 'Listen, a music sings,
> It's gone as soon as found,
> Yet there's a universe
>
> Which Bach and Mozart knew,
> Beethoven sometimes and
> Dowland often. There's
> A starlight brilliance too
> We but half-understand
> Yet recognise as true –
> The music of the spheres.'

Conclusion

Since the eighteenth century, it has been customary to consider music as mere entertainment – or later, as a useless by-product of evolution. In ancient times, however, music was viewed as a vital faculty that helped humanity to flourish.

Notes

1 James, J., *The Music of the Spheres*, (1993), Little, Brown & Co.

2 Crickmore, L., 'A re-valuation of the ancient science of harmonics', *Psychology of Music*, 31/4, (2003) : 391-403

3 Adam, J., *The Republic of Plato*, Vol. II, (1902), CUP : 452 (note on 617b)

4 For the development of the Greek octave species from the Babylonian heptachord see Crickmore, L. 'New Light on the Babylonian Tonal System' in *ICONEA Vol.2008*, edited by Finkel, I. & Dumbrill, R., Iconea Publications. For a speculative connection between Plato and Milton's 'nine infolded Spheres' (*Arcades*, 63ff), see *Research Note 3, Appendix I.*

5 Godwin, J., *Harmonies of Heaven and Earth*, Thames & Hudson, (1987) : 124-193

6 *Research Note 4* exemplifies the kind of flexibility required. Plato describes the unequal division of a line, but nowhere states which of the listed mental characteristics are to be associated with the longer and which with the shorter segments. This is because such a matter is purely contextual.

7 See Godwin, J., *The Harmony of the Spheres: a Sourcebook of the Pythagorean Tradition in Music*, (1993), Inner
Traditions International : 221-235, especially Figure 18

8 The orthodox history of 'speculative music' comprises a many-faceted commentary on the first part of Plato's *Timaeus*, which never sank entirely into oblivion during the dark and middle ages on account of a Latin translation of it by Calcidius. The musical scale which is described mathematically in the *Timaeus*, as part of Plato's description of the creation of the 'World Soul', consists of tones (9:8), plus semitones of the size of the part 'left over', *leimma*, (256:243). Musicologists call such tuning 'Pythagorean'. 'Just tuning', on the other hand, uses 16;15 as its semitone. As a result, there have to be two sizes of tone: 9:8 and 10:9. The major third is then 5:4, rather than 81:64. It consequently sounds 'sweeter' and corresponds to the modern harmonic series. References to 'Just tuning' are curiously absent from the extant literature of music theory, with the exceptions of Ptolemy's *Harmonics*, (2nd century AD), Zarlino's *Institutioni Harmoniche* (1558), and Kepler's *Harmonices Mundi* (1619).

9 Crickmore, L., New Light on the Babylonian Tonal System, in *ICONEA Vol. 2008*, edited by Finkel, I & Dumbrill R., Iconea Publications, (2009).

10 Crickmore, L., The Musicality of Plato, *Hermathena* no.180, (2006) : 19-43

11 Seife, C., *Zero: the Biography of a Dangerous Idea*, (2000), Souvenir Press : 214

12 Jennings, E., A Music Sought, *Tributes*, Carcanet

VIII One hundred and fifty three fishes

Research note 8 reflects on a single biblical number from arithmetic, geometrical, architectural, musical and mythological perspectives.

This note is a commentary on the first fourteen verses of the twenty-first chapter of the gospel of St. John, with special reference to a forgotten tradition of interpretation with regard to verse 11.

Seven of the disciples had been out fishing all night without catching anything. In the morning Jesus instructs them to cast their nets to the right of the boat. They do this and catch 'a multitude of fishes'. In verse 11, we learn that the fishes numbered 153, yet the net had not broken. Modern commentators tend to ignore the figure 153, assuming, perhaps, that for the ancient mind it represented

a multitude'. Thereby, they are ignoring an ancient gnostic tradition which suggests that the author's choice of number was both deliberate and specific. Ancient mathematicians were filled with an almost religious awe by various patterns of integers which they found beautiful – and early kind of number theory, in fact. Two sets of such patterning are pertinent to the passage with which we are concerned:

> 1) 153 is the sum of all integers up to the prime number 171. Also, 153 =17 x 9. Among the attempts by ancient mathematicians to find workable integer approximations for the diagonals of squares (*i.e.,* $\sqrt{2}$ in relation to the sides), Theon's method 2 produces the ratios 7:5 and 17:12. The former is applicable to dimensions divisible by 5 (*e.g.,* 60, the basis of the sexagesimal counting system), while the latter works for multiples of 12 (*e.g.,* 72, the smallest integer from which, using 2, 3 and 5, one can generate the tone-numbers of an octave of the ancient Greek Dorian mode in ratios of string-length). According to Plutarch, the number 17 could strike fear into the hearts of Pythagoreans, because it lay mid-way between 16 and 18, the only numbers representing rectangular areas for which the perimeter equals the area (*Cf.,* Research note 5)- *e.g.,* (4 x 4) = 4 + 4 + 4 + 4, and (6 x 3) = 6 + 3 + 6 + 3. 2) If each of the digits of 153 is cubed, their sum is itself 153 (13 + 53 + 33). This is more than a curious coincidence. Multiples and powers of 3 and 5 are the mathematical basis of Just tuning in ancient times. Scales would have been defined in 'regular' tone-numbers in the form 2p3q5r. The absence of 2 is not important, because multiples of 2 only generate octaves and do not alter the pitch-classification of a tone. The standard tables of 'regular' numbers with their reciprocals so commonly found in Mesopotamia contain only such numbers[3]. The gospel comment that 'the net had not broken' may refer to the fact that the science of harmonics, the musical/mathematical/geometrical framework on which the allegory depends, has remained intact – that is the necessary calculations are possible in integers.

Michell[4] argues that the story of the miraculous haul of fishes was adapted from earlier writings and that the gnostic Christians interpreted it using the same cabalistic methods which the Jews applied to their own scriptures. In the light of this, he ingeniously reconstructs 'the figure of sacred geometry which must originally have accompanied the story of the 153 fishes'. However, considerable caution is called for when dealing with matters such as this. The cabala is a valid method of rabbinic interpretation, just as symbolic geometry was a standard tool for mediaeval architects and builders. But both techniques have been hijacked by the New Age movement and turned into a lucrative industry. A more rigorous assessment of the geometrical implications of 153 can be found in the research work of Colin Dudley[5] concerning Canterbury Cathedral:

> 'All constructions in sacred geometry begin from the circle. Lanfranc's begins from a circle 153 feet in radius. (The English foot remains unchanged from that used in the Eleventh Century.) The number 153 was taken from the number of fishes that the gospels relate as having been caught in the net by the disciples from the Sea of Galilee on the advice of the resurrected Christ. Its symbolic import as a numerological sign for the whole Church of Christ is well known, and it has been shown that this same dimension of 153 feet was the module for the plan of Old St. Peter's Basilica in Rome.[6] In the Appendices, it will be shown that it was also the fundamental dimension for the plan of Hagia Sophia in Constantinople. The fact that the Cathedral Church at Canterbury was dedicated as the Church of Christ the Saviour is of significance in this context.'

Evidence for the continued use of 153 as a symbolic number is provided by the foundation of St.Paul's School by John Colet in 1510, for an intake of up to 153 boys.

Conclusion

It is possible that some Jews, trained as scribes in the city-states of Mesopotamia during their exile, incorporated aspects of Babylonian musical mathematics into their own scriptures. If this is so, biblical scholars may wish to be included alongside archaeologists, cuneiform scholars, musicologists, Greek scholars and historians of science and mathematics required to form the necessary interdisciplinary resource for further study of 'harmonic mythology'.

Notes

1 Theodorus of Cyrene was the first to prove that not just $\sqrt{2}$ (see **Research Note 6**) but also numbers like $\sqrt{3}$ and $\sqrt{5}$ and up to $\sqrt{17}$ are irrational. It is not known why he stopped at 17. Choike J. R. 'Theodorus' Irrationality Proofs', *The Two-Year College Journal*, (1980) suggests that it was because the method he probably used becomes unworkable at this point.

2 Theon of Smyrna, *The Mathematics Useful for Understanding Plato* – trs. R. & D. Lawlor – (1979) Wizard's Bookshelf, San Diego : I XXXI. See also Lawlor, R., Sacred Geometry, (1982), Thames & Hudson : 40-1

3 See for instance Hilprecht, H.V., The Babylonian Expedition of the University of Philadelphia – Series A; Cuneiform Texts (Hilprecht, ed.), Vol. XX, Part I, published by the *Department of Archaeology, University of Pennsylvania* (1906): Pls. 10, 11, 12, 14 : CBM 11340 + 11402, 11368, 11909, 11097

4 Michell, J., *The Dimensions of Paradise*, Thames & Hudson, (1988) : 174-8

5 Dudley, C., *The Sacred Geometry of Canterbury Cathedral*, (1993),privately printed : 15; now also available on the web: http://www.medievalarchitecturalgeometry.com/canterbury

6 Bannister, T. C., 'The Constantinian Basilica of St. Peter at Rome', *Journal of the Society of Architectural Historians,* Vol. 27, (1968) : 20-1

IX Harmonic mythology

Research note 9 summarizes some reasons for proposing the new term 'harmonic mythology' to describe a freshly evolving branch of archaeomusicology.

'Harmonic mythology' is a term coined by Graham Fearnhead[1] to classify the serious interdisciplinary study of the synthesis between ancient myth and the science of sound, or more specifically, the modern harmonic series. This neologism was designed to establish an accurate description of a newly evolving field of academic study. To be classified as 'harmonic mythology', a phenomenon needs (a) to be satisfactorily documented as 'myth', and (b) its implicit arithmetical symbolic expression must correspond strictly to the ratios of the harmonic series, or the ancient tradition of 'speculative music' attributed to Pythagoras and exemplified by writers such as Plato, Ptolemy, Nicomachus, Boethius and Kepler. Joscelyn Godwin[2] has published two useful collections of such material. Fearnhead's interest in the topic arose from his reflections about Plato's view of music in the light, for instance, of the speculations of Ernest McClain[3].

The concept of 'harmonic mythology' is underpinned by a broad theory. One of the first achievements of early empirical science must have been the discovery that the pitch of a note sounded by a pipe is raised an octave (that is, it retains the same pitch classification) when the pipe is cut in half –whatever its original length or pitch. In ancient China[4], there seems to have been a rule of thumb used by instrument makers for tuning an instrument through a series of rising fourths and falling fifths: 'add or subtract one third'- that is, from successive pipe-lengths. In proportional arithmetic that would be: x 4/3 and 2/3 alternately. These discoveries would later have been applied in the calculation of string-lengths. It is the invariant quality of these musical phenomena with time which often finds them incorporated into Creation Myths and Deity Mythologies so satisfying a need for a timeless permanence to the story and a means of 'bringing it to earth' with the contemplation of the musical ratios derived by the ancient philosophers and priests.

As a prime example of harmonic Mythology, in his *Timaeus* (34-37) Plato describes the construction of the 'World Soul' as a musical scale with the ratios of Pythagorean tuning: 9:8, 9:8, 256:243, 9:8, 9:8, 256:243, 9:8. If interpreted as ratios of string-length, this would sound the falling scale of the Greek Dorian octave species[5] – Plato's 'genuinely Greek' mode (*Laches,* 188d). Crickmore[6] also believes that another form of this scale *(nīd qablim)* had been in use in ancient Babylon, where it could have been quantified in the ratios of just tuning, using numbers taken from the standard Mesopotamian tables of 'regular' numbers and their reciprocals. If this is correct, the falling scale equivalent to the Greek Dorian octave species, quantified in Babylonian reciprocal ratios, would be defined: 60, 54, 48, 45, 40, 36, 32, 30. Of these numbers, 60 is the arithmetical name for the god, Anu; 40 for Ea, patron of music; and 30 for the god, Sin[7]. In the rising Babylonian heptachord from 30-54 *(išartum)*, the fourth string (40) is called 'Ea-created' (UET VII 126).

While in the epic Gilgamesh, the name of the boatman who sails across the waters of death is Urshanabi (Old Babylonian Sursunabi), which means 'servant of two-thirds' 8(60 x 2/3 = 40). In various Near Eastern cultures, the superparticular ratios defining the various intervals of these two scales (3:2, 4:3, 5:4 etc) appear to have been projected onto the heavens as astronomy/astrology, and into the proportions of sacred buildings, including, later in the West, our mediaeval cathedrals[9].

The Yuga numbers of Hindu cosmology provide yet further examples of harmonic mythology[10]. Some modern biblical scholars[11] are beginning to consider the possibility that there are aspects of harmonic mythology in the numerology of the bible. In his book *The Dimensions of Paradise*, John Michell[12] writes:

> 'Ancient science was based like that of today on number, but whereas number is now used in the quantitative sense for secular purposes, the ancients regarded numbers as symbols of the universe, finding parallels between the inherent structure of number and all types of form and motion.'

Finally, the mathematician, Jay Kappraff[13], raises an even profounder question when he asks: 'Is it not possible that our brains are wired to the tones of the diatonic scale, an area for neuroscientists to explore?' If experiment ever showed this to be the case, we would already be some way along the road towards a world-view in which music and science have been re-united. For as Steven Mithen, Professor of archaeology at the University of Reading, has written[14]:

> 'While several other universal attributes of the human mind have recently been examined and debated at length, notably our capacities for language and creative thought, music has been sorely neglected. Accordingly, a fundamental aspect of the human condition has been ignored and we have gained no more than a partial understanding of what it means to be human.'

Overall conclusion

Much of the evidence presented in these nine Research Notes is inevitably circumstantial and dependent on interpretation. Nevertheless, it points in one direction: towards the probability that for centuries a musical and mathematical oral tradition (or traditions) existed across the whole of the Near East. Later documentary evidence

from Greece for some aspects of this tradition may now have to be re-interpreted as formalization rather than as innovation. The primary evidential source for all the musical/mathematical ideas contained in these nine research notes lies in a number of cuneiform tablets, usually classified as 'mathematical' but which are in fact 'musical', namely: (1) the tables of thirty 'regular' numbers with their corresponding reciprocals found frequently in Mesopotamia; and (2) tablets, the contents of which are restricted to the integers 1-7 or 1-9, interpreted by musicologists as referring to the strings of seven and nine-stringed instruments, respectively[15]. In Babylon, the former were used as 'tone-numbers' to define musical pitches; the latter to define the tuning procedures for different modes. It would be premature, therefore, to dismiss the general thrust of these research notes with the comment 'there is no evidence for...'. For even were such a judgment accurate with respect to particular instances, in an exploratory field of the kind we are considering, there is a need for a generous and open-minded approach which recognises that missing evidence may once have existed but no longer be extant, or that it might still exist in some cuneiform tablet that so far has not been transcribed. The total number of such tablets lying in the museums of the world must be enormous.

A new area for serious scholarship has been identified. Moreover, it is an area that cannot be usefully pursued within the constraints of any single discipline. It is an area calling for interdisciplinary investigation, involving teams of scholars with expertise in some or all of the following disciplines, according to the particular question to be explored: archaeology; cuneiform studies; musicology; Greek; history of science and mathematics; religious and biblical studies. The scholars from each of these disciplines will need to respect the differing methodologies and criteria of their new colleagues and through debate establish a common purpose and understanding.

I conclude, therefore, that there is a need for further interdiciplinary research into this new evolving branch of archaeomusicology. And that such a field of study should be known as 'harmonic mythology'.

Notes

1 Crickmore, L., The Tonal Systems of Mesopotamia and Ancient Greece: Some Similarities and Differences, *ARANE*, (2008), http://www.iconea.org/arane.htm: 13-14

2 Godwin, J., Music, Mysticism and Magic: a Sourcebook, (1968), Penguin Group; *The Harmony of the Spheres: a Sourcebook of the Pythagorean Tradition in Music*, (1993), Inner Traditions International

3 McClain, E. G., *The Myth of Invariance*, (1976), Nicolas-Hays; *The Pythagorean Plato*, (1978), Nicolas-Hays; *Meditations through the Quran*, (1981), Nicolas-Hays

4 Crickmore, L., A New Hypothesis for the Construction and Tuning of Babylonian Musical Scales, *Journal of Ancient Civilizations*, (2007), Vol. 22 : 35-67

5 Crickmore, L., A re-valuation of the ancient science of harmonics', *Psychology of music*, 31/4,(2003): 391-403

6 Crickmore, L., A Musical and Mathematical Context for CBS 1766, *Music Theory Spectrum*, 30/2, (2008): 327-338

7 Livingstone, A., *Mystical and Mythological Explanatory Works of Assyrian and Babylonian Scholars*, (1986), Clarendon press, Oxford: 330-33

8 Mitchell, S., Gilgamesh, Profile Books, (2004): 290

9 Dudley, C., (2007) http://www.medievalarchitecturalgeometry.com

10 See Research Note 4

11 *e.g.*, the publications of writers such as Duane Christiansen and Dan Olson

12 Michell, J., The Dimensions of Paradise, (1988), Thames & Hudson: 7. See also Research Note 5.

13 Kappraff, J., Beyond Measure: a Guided Tour Through nature, Myth and Number, (2002), World Scientific: 562

14 Mithen, S., *The Singing Neanderthals*, Weidenfeld & Nicolson, (2005) : 1

15 In particular, I have in mind: (1) MLC 1670; CBM 11340 + 11402; 11368; 11909; 11097; and (2) CBS 10996; UET VII 74; CBS 1766 and UET VII 126. See also: Dumbrill, R. J., 'Four Tables from the Temple Library of Nippur: A Source for 'Plato's Number' in relation to Quantification of Babylonian Tone Numbers', http://www.iconea.org/arane.htm

APPENDIX: THE BYROM COLLECTION

Evidence from some drawings in the Byrom Collection suggests that the collection may exemplify one of the final manifestations of the tradition of Harmonic Mythology before its eclipse by modern science.

The Byrom Collection comprises 516 geometrical drawings of which John Byrom (1691-1763), a Jacobite sympathiser, was the custodian. In 1992, Joy Hancox, who had discovered these drawings while writing her biography of Byrom[1], published a general book about them[2]. In one of the drawings[3], Mrs Hancox noticed 'seventy-two pinpricks in groups of eight'[4]. From these she devised a special ruler, which she used to measure and interpret the other drawings. Mrs Hancox also discovered that a number of the drawings had been printed from brass plates belonging to the Boyle Collection (part of the King George III Collection) in the Science Museum[5].

Joy Hancox has kindly allowed the present author access to drawing no. 291[6] and a copy of her ruler. This drawing consists of two interlocking sets of concentric circles. The diameters of the outer range of the lower set (reading outwards from the centre and using Mrs Hancox's '72-rule') are:

30, **32**, **36**, **40**, 41, 42, **45**, **48**, 51, **54**, 56, **60**

The numbers in bold type all occur in Mesopotamian lists of standard 'regular' numbers with their reciprocals[7]. Of the remaining figures 42, 51 and 56 (underlined) are Diophantine approximations for $\sqrt{2}$, used to estimate the length of the diagonal of squares of sides 30, 36 and 40, respectively, as demonstrated by Theon[8] (2nd century AD). Thus, 30 x 7/5 = 42; 36 x 17/12 = 51; 40 x 7/5 =56. 41 appears to have been included to form a rim to the circle d = 42.

The centre of the upper set of concentric circles has been placed at 42 units – that is, at a Diophantine approximation for an irrational number – above the centre of the lower set. The outermost of the upper set of circles also has a diameter of 42 units. The upper set of circles encloses a seven-pointed star[9]. There is also a separate uncoloured eighth (octave) point.

Returning to the diameters in the lower part of the drawing, of the numbers in bold type, the first seven, interpreted as 'tone-numbers' define the Babylonian heptachord *išartum* (rising) or *embūbum* (falling) in ratios and reciprocal ratios of pipe or string-length[10]. With the added octave 'tone-numbers' (60 rising and 27 falling), these scales become the ancient Greek Dorian and Phrygian octave species, respectively – the only two modes whichPlato would admit into his ideal cities (Republic, 398-99c). It should be observed, however, that the two Greek modes are defined here in Just tuning rather than the more usual Pythagorean. Joy Hancox interprets drawing no.291 from the Byrom Collection, as the geometry underlying an engraving by Theodore de Bry: The Theatre of Human Life (*Theatrum Vitae Humanae)*, Metz, 1596[11]. This engraving appears in a book of the same name by Jean Jacques Boissard. Frances Yates[12] reproduces the engraving and likens it to the speech of Jaques in Shakespeare's As You Like It (Act II, scene vii): '*All the world's a stage....*'. The Byrom Collection also contains a drawing, printed from the brass plates, which Mrs Hancox judges to be a 'parametric' design for the Globe Theatre (1599). All the concentric circles listed by their diameters from drawing 291 can also be found in the 'Globe' drawing.

Conclusion

The originators of the drawings discussed in this research note appear to have been familiar with a musical/mathematical tradition of geometrical presentation which can be traced back to Plato and as far as ancient Babylon. The present author, therefore, strongly endorses Joy Hancox's appeal for sponsorship and publication of a facsimile of the Byrom Collection with a view to enabling interdisciplinary teams of scholars thoroughly to investigate its cultural significance.

Notes

1 Hancox, J., *The Queen's Chameleon*, (1994), Jonathan Cape

2 Hancox, J., *The Byrom Collection*, (1992), Jonathan Cape. Paperback, 1997.

3Hancox, J., *The Byrom Collection*, (1992), Jonathan Cape: 75

4 *Cf.* 'For the purposes of printers and designers the foot was divided into 12 inches and the inch into 12 lines or 72 points. The foot therefore consisted of 864 points'. (Michell, J. *The Dimensions of Paradise*, (1988), Thames & Hudson: 82).

5 Museum Reference: 1927-2065.

6 See Figure 2.

7 *e.g.*, MLC1670; CBM 11340+11402; 11368; 11909; 11097 (c. 2200-1700 BC).

8 Theon of Smyrna, *The Mathematics Useful for Understanding Plato* (trs. From Greek/French edn. Of J. Dupuis by R & D Lawlor), San Diego (Cal.), Wizard's Bookshelf, (1979).

9 *Cf.,* the seven-pointed star in cuneiform tablet CBS 1766. Also, Crickmore, L., 'A Musical and Mathematical Commentary on CBS 1766', *Music Theory Spectrum*, 30/2 (2008): 327-338; in particular, Example 8, p.335. Dudley, C., *The Sacramental Geometry of Peterborough Cathedral*, Ph D. thesis, University of South Australia, (2000): 421, has demonstrated how a simple development of the basic ancient *ad quadratum* construction can be used to draw a heptagon.

10 Crickmore, L., 'A Musical and Mathematical Commentary on CBS 1766', *Music Theory Spectrum*, 30/2 (2008): 333, Example 7.

11 Hancox, J., *The Byrom Collection*, Jonathan cape, (1992): 104-9 and Figure 4.

12 Yates, F. A., *Theatre of the World*, Routledge & Kegan Paul, 1969: 165-8 and Plate 23.

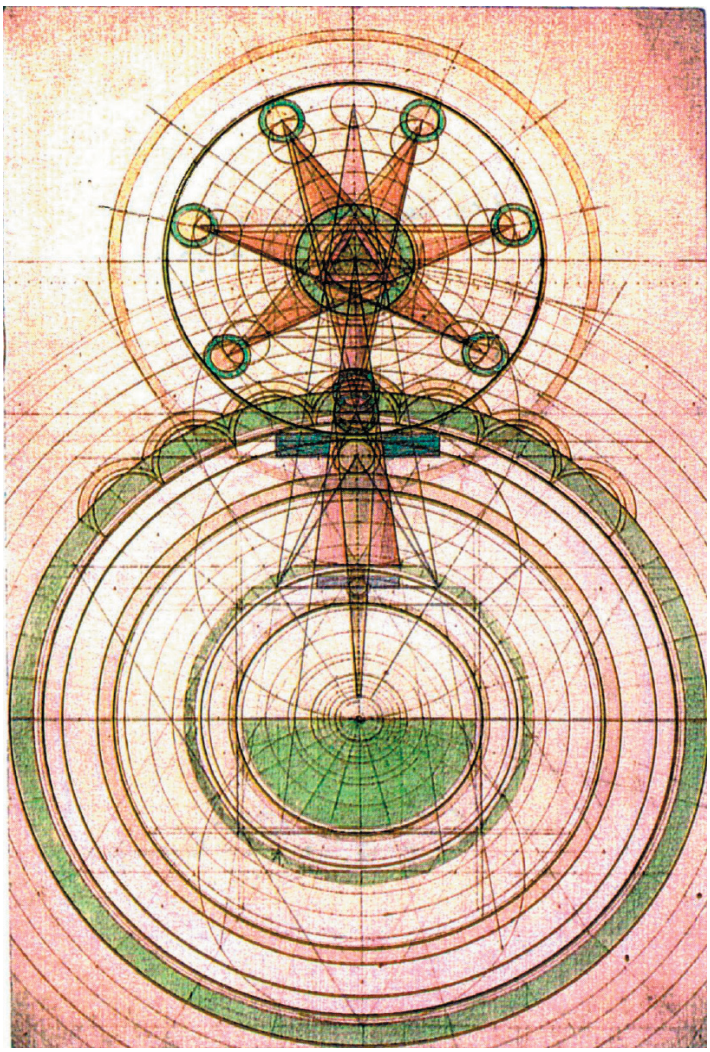


Fig.2. Byrom Collection drawing 291
Reproduced with permission for purposes of scholarship
© Joy Hancox, The Byrom Collection, Cape, 1992

BM 127469
PRN:WCO2560; Reg. No.: 1931,1010.480. Excavated at Ur. Acquired in 1931

THE HORN QUARTET: A STUDY OF BULL, COW, CALF AND STAG FIGURES ON SUMERIAN LYRES

Myriam Marcetteau

The study of music in the Ancient Near East is a recent science and it is only in the past five decades that scholars understood that third millennium Mesopotamia held essential keys to the origins of music.[1]

This paper is a study of zoomorphic lyres, extant and depicted, of that period. The extant types were excavated by Sir Leonard Woolley in the late twenties at the Royal Cemetery at Ur. They date from the 27th to the 26th century.

Iconography only depicts lyres of the bull-lyre type (Figs.C), but extant instruments show that there were also cows, calves, and stags which ornated them (Figs.B), in addition to the well known model (Figs.A)

In the late twenties Woolley had already noticed this peculiarity and concluded that the four animals embodied the four registers of the musical ambit: bass, tenor, alto, and soprano.[2]

This paper offers an alternative interpretation based on aesthetical symbolism. I shall begin with the recurring bull figure, both extant depicted, and then look at a possible interpretation of metaphors, hidden within the cow, the calf and the stag.

The bull: *a fertility symbol for a primitive source of musical inspiration*

The bull is the most frequently represented of all animals in Mesopotamian iconography. Its association with worship[3] and music is well attested. It is always lavishly represented on extant models (Figs.A). It is not surprising that whenever musical scenes were depicted, the bull-lyre was always the star of the party (Figs.C, n°4-7).

What could be the reason for this relationship between bull and music? The bull, as a symbol, embodies its own strength along with the wild and powerful forces of nature[4]: fierce, uncontrollable and unpredictable power. Simultaneously, these forces symbolise fertility and exude fecondity - the primeval link, the bull's prerogative.[5]

> '*The reproductive power of this animal was only considered within its maternal value at an ancient age when, apparently, man had not yet discovered its purpose in the reproduction process. [...] It is also noticeable that during the Neolithic period, when both agriculture and rearing, appeared that the bull was still associated to the pregnant mother goddess.*[6]'

This symbol of fertility places the bull at the pinnacle of musical inspiration: everything leads to musical fecundity. In other words, the bull is a reminder that initially music found inspiration in Nature. In all primitive music, creativity finds its sources within the sounds of wind, water, thunder, or from animal eructation, the calling of birds, and so forth.

Metaphorical value of the bull-lyre

The bull does more than embellish the lyre: the bull is the lyre. The soundbox borrows its shape, often with great realism, the bull's head overhangs its body (Figs. A, n°2-4), and there are also occurrences where legs, and probably its penis, are also represented (Figs.C, n° 1, 4, 6 and 7).

The bull's metamorphosis into the lyre is a metaphor of human intelligence when appreciated intellectually but if it is perceived physically, it becomes a metaphor of Nature's power at its best.

The combination of these diverging perceptions evoke the acute contrast between Nature as the primeval source of inspiration, symbolised with the bull figure, in contrast with sophisticated cultural inspiration. This complexity infers man's intellectual taming of Nature's instability, his intellectual instinct of domination over nature's wild powers and his subconscient need to channel these powers into artistic development. The bull has become the untameable strength with which all aspire at exerting influence.[7] The bull-lyre had other fantastic powers: it would have breathed life into musical instruments, as any god would have in the inanimate.[8] The bull-lyre had acquired a divine purpose: it had become a mystic tool, the magical sound of which, likened to the roaring of the bull[9], allowed for mortals to communicate with the gods when they played of it.

Symbolism of cow and calf

The bull figure, either on extant or depicted lyres, symbolises man's inner will to overcome and transcend his primitive desires into an artistic form. But the ultimate goal remains the quest for communication with the gods. In addition to bull-lyres,[10] other isolated cows and calves' heads excavated at the same site have been identified as lyre decorations (U.10577, U.10916, and U.12435)[11]. However, neither cow nor calf seem to bear any significant musical symbolism[12]. There, the metaphor for the bull-lyre seems to be lost.

Cow and calf figures might have become transfigurations for the worship of the bull, because the bull had kept its status over its kind. So powerful might have been its influence that it would have mutated into other bovine representations. Another explanation may be that the sound box of the lyre was made, not of bull hide, ^{kuš}*šinuntu*, less often ^{kuš}ri-mi, but of cow or calf.

Horns as a primeval symbol

Our interpretation of Mesopotamian iconography mainly relies on symbolism. On bull-lyres, it is the bull's horns which are the driving force of our attention because they are the acrocratic representation for the whole animal. Either realistically or crudely represented, with rough representation of bodies, eyes missing, etc., horns are always carefully carved, and frequently over emphasised (Figs.A, 1, 3, 4; Figs.B, 1-3; Figs.C, 1-7).

Another reason for our attention been driven to the horns might be that:

> *'...the horn shape, and in particular bull's shows two opposite figures relative to androgyny – for the single horn symbolises both the erectile phallus and a weapon able to stab human flesh, whereas the pair of horns draws the harmony of a lyre and, resting on the front part of the animal, becomes the metaphor of a curved receptacle and a feminine matrix.*[14]'

Here again, the symbolism of the horns expresses the duality of the bull figure through the feminine and masculine principles, the source of fertility and fecundity indispensable to musical inspiration and artistic creativity.

Later, in Greco-Roman antiquity, we see Apollo, the god of the arts, music and poetry, whose main attribute is the lyre, often depicted holding[15] a pair of bovid's horns.

The stag and the cycle of music

Let's now focus on the two stag figures from the Royal Cemetery. The first one ornates the front of the extant silver lyre U.1235 (Figs.B,4); the second is an isolated stag figurine made of copper U.12356. (Figs.B,5).

The stag is not a bovid. However, symbolism shows that in Sumerian culture, its mystical influence was almost as important as the bull's. Therefore the stag must have become a mythico-cosmological pair[16] with the bull. Should another animal have been linked symbolically to a musical instrument, it would have had to be the stag because of its protruding antlers. They have the appearance of tree branches and renew each year. The stag is regarded as a symbol of time revival and cycle of life.[17] The stag is connected to time, as its antlers suggest. There cannot be music without time. The stag figure embodies the reciprocal of the bull. If the latter opens the Cycle of Life as a symbol of musical inspiration, which constitutes the first step in music making, the stag, to the contrary, closes the cycle so as to allow for its renewal since it expresses tehe revival of time.

As for cows and calves, they might have represented the passing of time, the development between the opening and the end of the cycle for they seem to establish the intermediary transition between the very first stage symbolised by the bull and the last stage, by the stag.

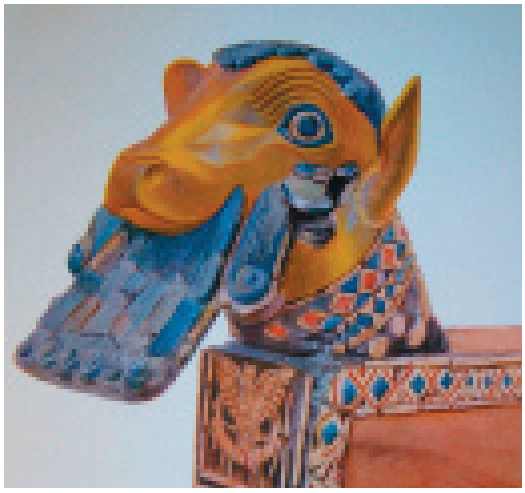
Conclusion

The bull, the stag, the cow and the calf ornating the Ur lyres are to be considered as a group. Symbolically, they represent the deep and necessary links between music and time as they amount to a seamless entity the purpose of which is the embodiment of metaphor in the cycle of music through its successive stages in time: its birth, its development and its end.

ILLUSTRATIONS

FiguresA : Extant bull lyres
from the Royal Cemetary of Ur

No.1. Golden bull head with lapis-lazuli, embellishing the front of the lyre U.10556. From: Woolley, Sir Leonard, 'The Royal Cemetery': A report on the Predynastic and Sargonid graves excavated between 1926 and 1931, in *Ur Excavations II,* London/New-York, The Trustees of the British Museum and of the Museum of the University of Pennsylvania, plate 107.



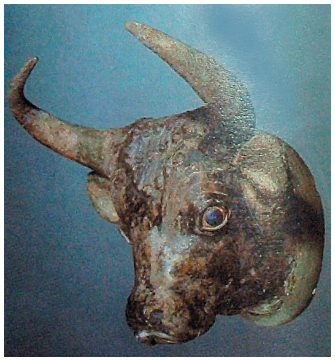
No.2. Golden bull head with lapis-lazuli, embellishing the front of the lyre U.10412. From: Woolley, Sir Leonard, 'The Royal Cemetery': A report on the Predynastic and Sargonid graves excavated between 1926 and 1931, in *Ur Excavations II*, London/New-York, The Trustees of the British Museum and of the Museum of the University of Pennsylvania, plate 110.

No.3. Silver bull head embellishing the front of the silver lyre U.12354. from: « La Musique Antique », in *Les Dossiers de l'Archéologie*, Dijon, Faton, 1989, n°142, p. 35.

No.4. Golden bull head adorning the front of the lyre U.10353. From: Woolley, Sir Leonard, 'The Royal Cemetery': A report on the Predynastic and Sargonid graves excavated between 1926 and 1931, in *Ur Excavations II*, London/New-York, The Trustees of the British Museum and of the Museum of the University of Pennsylvania, pl. 114.

Figures B: More zoomorphic lyres from the royal cemetary of Ur

No.1. Calf copper head U.10577, which must have embellished the front of an actual lyre. From: « La Musique au Proche-Orient Ancien », in *Les Dossiers de l'Archéologie*, Dijon, Faton, 2006, n°310, p. 14.



No.2. Cow silver head U.10916, which must have embellished the front of an actual lyre. From: « La Musique au Proche-Orient Ancien », in *Les Dossiers de l'Archéologie*, Dijon, Faton, 2006, n°310, p. 10.

No.3. Cow copper head, embellishing the front of the lyre U.12435. From: « La Musique au Proche-Orient Ancien », in *Les Dossiers de l'Archéologie*, Dijon, Faton, 2006, n°310, p.10.

No.4. Silver stag embellishing the lyre U.12355. Source: Woolley, Sir Leonard, 'The Royal Cemetery': A report on the Predynastic and Sargonid graves excavated between 1926 and 1931, in *Ur Excavations II*, London/New-York, The Trustees of the British Museum and of the Museum of the University of Pennsylvania, plate 112.

No.5. Copper stag figurine U.12356, must have embellished an actual lyre. Source: Woolley, Sir Leonard, « 'The Royal Cemetery': A report on the Predynastic and Sargonid graves excavated between 1926 and 1931 », in Ur Excavations II, Londres/New-York, The Trustees of the British Museum and of the Museum of the University of Pennsylvania, plate 113 a.

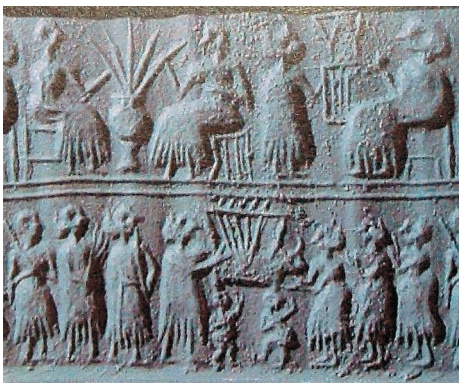
Figures C : Some bull lyres in third millennium iconography

No.1. Detail of the Standard of Ur. From: La Musique au Proche-Orient Ancien, in *Les Dossiers de l'Archéologie*, Dijon, Faton, 2006, n°310, p. 11.

No.2. Detail of the stele of Gudea. Source: La Musique au Proche-Orient Ancien, in *Les Dossiers de l'Archéologie*, Dijon, Faton, 2006, n°310, p. 58.

No.3. Portable bull-lyre on a plaque from Mari, M.2459. From: Parrot, André, *Mission Archéologique de Mari III*, Paris, Librairie Orientaliste Paul Geuthner, Collection de l'Institut de France d'Archéologie de Beyrouth, pl.15.

No.4. Detail of the shell plaque embellishing the front of the Ur bull-lyre U.10556. From: La Musique au Proche-Orient Ancien, in *Les Dossiers de l'Archéologie*, Dijon, Faton, 2006, n°310, p.13.

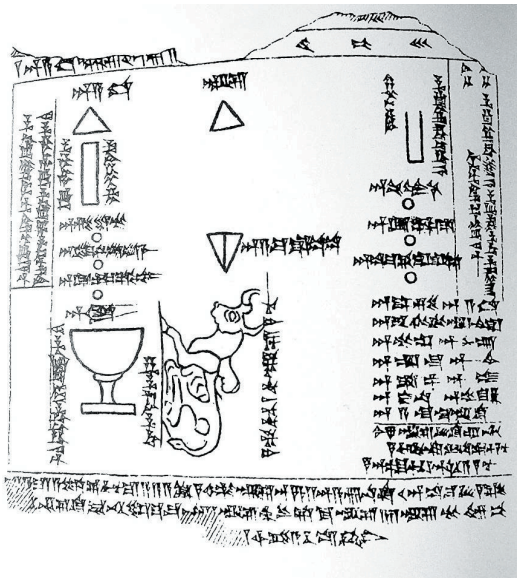


No.5. Seal Impression of Dumusikal cylinder, Ur grave PG.1237. From: La Musique au Proche-Orient Ancien, in *Les Dossiers de l'Archéologie*, Dijon, Faton, 2006, n°310, p.41.

No.6. Impression from Ur Seal U.11904. From: Woolley, Sir Leonard, 'The Royal Cemetery': A report on the Predynastic and Sargonid graves excavated between 1926 and 1931, in *Ur Excavations II*, London/New-York, The Trustees of the British Museum and of the Museum of the University of Pennsylvania, plate 193 n°21.

No.6. Impression from Ur seal U.11904. From: Dumbrill, Richard, *The Archaeomusicology of the Ancient Near East* (Illustrations : Yumiko Higano), Trafford Oxford, Victoria, 2005, p.236.

Figures D : Addenda



No.1. Detail of the transcription of the '*kalū* ritual' tablet AO.6479 from Warka (Seleucid period). From: François Thureau-Dangin, *Le rituel du kalū*, I-IV, especialy I and II (Paris: Leroux, 1921), p.1-15.

No.2. A bronze figurine of Apollo holding a pair of horns. GR 1908.4-13.1 (Greece 1050-520 BC). Author's photograph. BM G.13

Notes

1 Dumbrill, R.J., *The Archaeomusicology of the Ancient Near East*, Trafford Publishing. Oxford, Victoria. (2005)

2 Woolley, Sir L., *Ur Excavations II : The Royal Cemetery, a Report on the Predynastic and Sargonid Graves excavated between 1926 and 1931.* London/New-York, Published by the Trustees of the British Museum and of the Museum of the University of Pennsylvania. (1934), pp. 249-261

3 The bull mainly appears during processions, religious sacrifices, and worship (both in cuneiform texts and Mesopotamian iconography).

4 This might be due to a strong dynamic connexion between the impressive sound of a storm and the row of the bull's hooves: see further, the quotation of the Gudea's cylinder A, footnote n°9.

5 Consequently, it is not surprising that Mesopotamian worship kept this association between the bull, the gods of fertility, and women (e.g. : Inanna/Ištar) : see for example the myth of Gilgameš.

6 Michel Cazenave, *Encyclopédie des symboles.* Paris Encyclopédie d'Aujourd'hui. (1989) La Pochothèque, p.666

7 Chevalier, J., and Gheerbrant, A., *Dictionnaire des Symboles, Mythes, Rêves, Coutumes, Gestes, Formes, Figurines, Couleurs, Nombres.* Paris, Laffont, (1982), p.739.

8 Bull-lyres are exclusively found in religious scenes. Moreover, we know that the *alû*, which was made with ^{kuš}ri-mi ('bull skin'?), was a cultual instrument (Myriam Marcetteau, unpublished doctoral thesis, forthcoming). Lastly, we know that without a bull sacrificed according to a complex ritual, the *lilissu* would not possess any mystical or magical power. See the Seleucid tablet AO.6479 of Warka, *in* François Thureau-Dangin, *Le rituel du kalû*, I-IV, especially I and II, Paris, Leroux, (1921), p.1-15 + Addenda to this article, Plate IV, 1.

9 The sound of the lyre is likened to a 'bellowing bull': Gudea, Cylinder A, col. XXVIII, l. 17.

10 The 1st dynasty copper bull head U.17887 might have belonged to a lyre as well, because it shares the same characteristics as the bull's head found near extant music instruments.

11 See also the the stag-lyre below.

12 The cow is a traditional icon of the Mother-Goddess. It is the nourishing earth, but the calf does not seem to symbolise anything at all and if associated with the ox, then it is only the domesticated therefore the castrated counterpart of the bull.

13 As an example, the unpublished Tablet from Mari = A.471 presents a request for an ox skin to make an *alû* instrument.

14 Jean Chevalier and Alain Gheerbrant, *Dictionnaire des Symboles, Mythes, Rêves, Coutumes, Gestes, Formes, Figurines, Couleurs, Nombres* (Paris : Laffont, 1982), p.166.

15 For an example of a Greek Apollo holding a pair of horns, see the Addenda: Plate IV, 2.

16 Jean Chevalier and Alain Gheerbrant, *Dictionnaire des Symboles, Mythes, Rêves, Coutumes, Gestes, Formes, Figurines, Couleurs, Nombres* (Paris : Laffont, 1982), p.112.

17 *Idem.*